Sixteenth Annual Meeting — American College of Chest Physicians
St. Francis Hotel, San Francisco, California, June 22-25, 1950

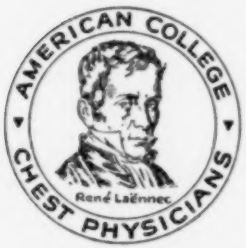
VOLUME XVII NUMBER 4

DISEASES

of the

CHEST

OFFICIAL PUBLICATION



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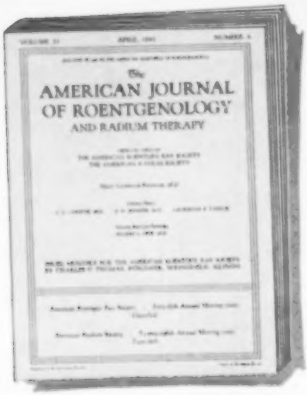

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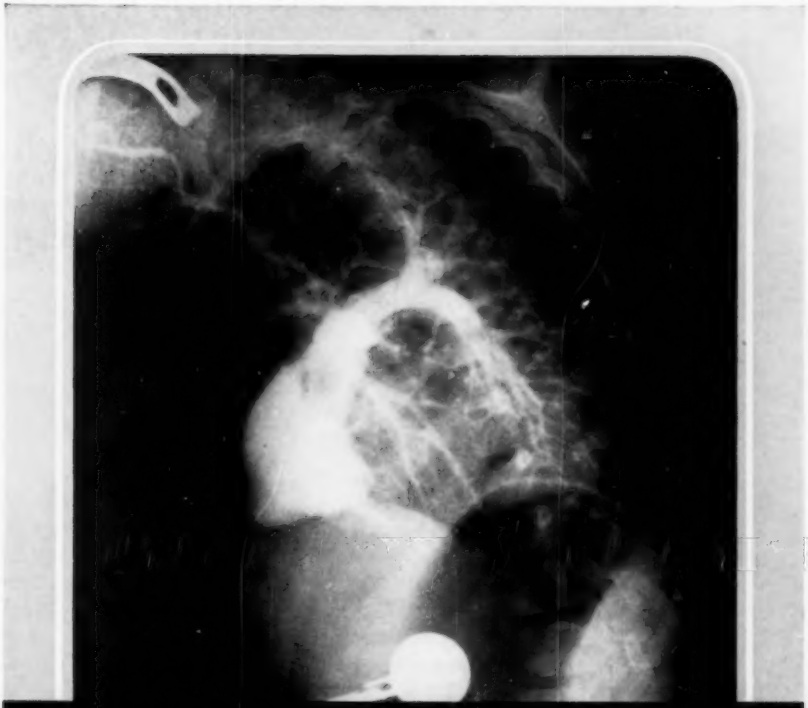

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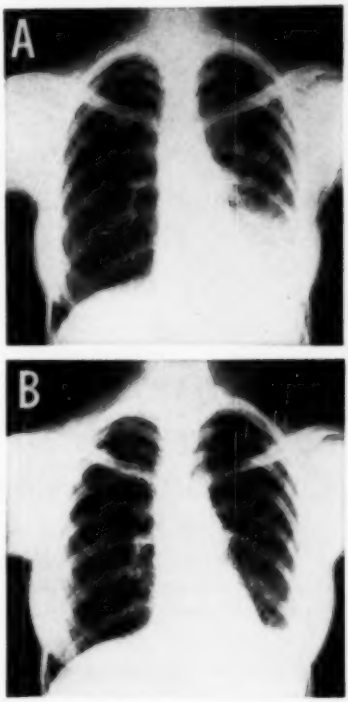

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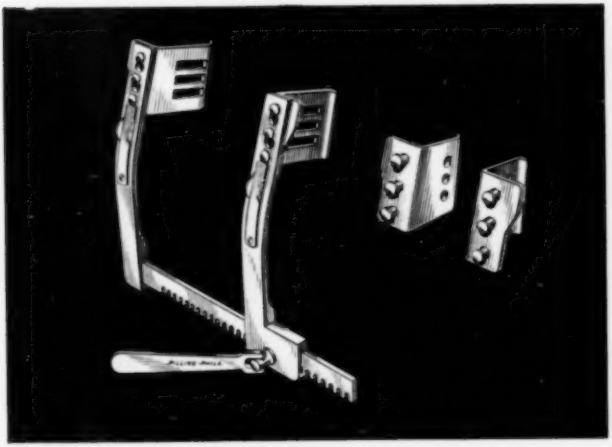

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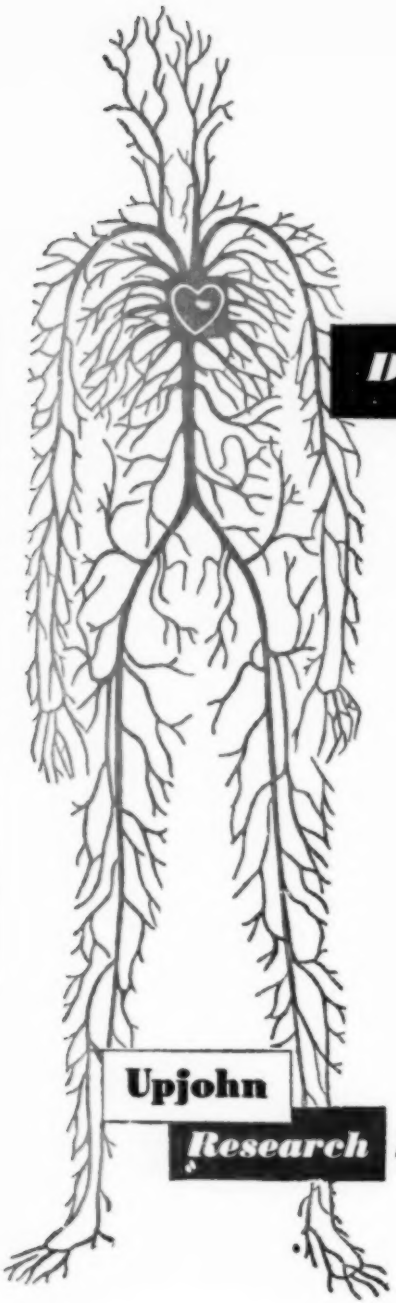

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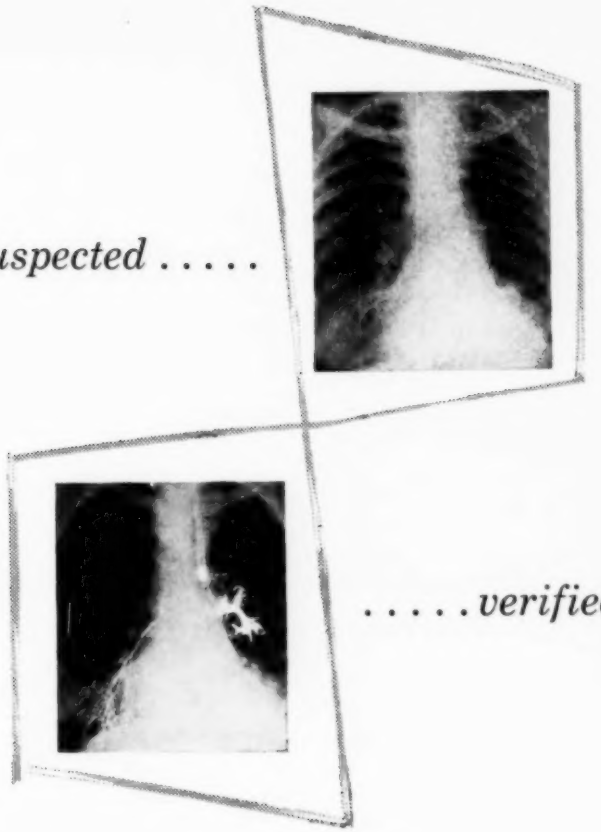

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VOL. XVII APRIL 1950 NUMBER 4

Etiology, Treatment and Surgical Indications of Non-Tuberculous, Non-Traumatic Spontaneous Pneumothorax*

G. L. CRENSHAW, M.D., F.C.C.P.
Oakland, California

Spontaneous pneumothorax, in the apparently healthy is a common clinical entity. In a period of five years 86 cases have been seen by the author. These do not include pneumothoraces occurring as a part of or secondary to pulmonary disease, such as, tuberculosis, lung abscess, infarct, or lung tumors, or to trauma and external violence. Where an underlying disease is known to be related, the treatment is directed not only to the control of the pneumothorax but toward the disease itself.

In the 86 cases the age varied from the new born of a few hours to 72 years, occurring most frequently in the young adult male. Severe exertion as the immediate cause was a contributing factor in only a few, as many occurred while the patients were at rest. The period of disability ranged from none to months of invalidism or semi-invalidism. Two deaths in this series were due to rapid collapse with extreme tension so that patients died before medical aid could be administered. In most cases, only a single attack occurred with rupture of the bleb or bulla and sealing of the fistula, following which the lung reexpanded uneventfully. In 23 of the 86 cases there was recurrence on the same side or opposite side. These recurrences varied in number from a second attack to one patient known to have had 22 attacks on the same side. (The latter has repeatedly refused surgical exploration). In 10 cases, the lung remained collapsed after two to three months or longer and after this length of time there seemed little likelihood of reexpansion. We have classified these cases as "persistent

*Presented at the 15th Annual Meeting, American College of Chest Physicians, Atlantic City, New Jersey, June 4, 1949.

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spontaneous pneumothoraces" and thoracotomy was done with excellent results, as described later.

There is considerable controversy regarding the etiology of spontaneous pneumothorax of the type under discussion. There is still a persistence of the feeling that tuberculosis is the underlying cause; however, when tuberculosis is present the lung collapses usually because of the rupture of a cavity, or in the presence of easily demonstrable disease. In our cases, tuberculosis was ruled out as far as possible as an underlying cause and there has been no evidence of it in later follow-up, in any case. In slightly less than half of the cases, there was no reaction to the tuberculin test (Mantoux) in all dilutions. In the 10 cases in which thoracotomy was done none showed macroscopic or microscopic evidence of tuberculosis. In one other case, described later under differential diagnosis, thoracotomy was necessary to prove the diagnosis. Here, small bullae were seen in a healed tuberculous area but the larger bleb that was so space-consuming occurred in a non-infected area. Lobular and segmental localized emphysema with bullae and bleb formation, occurring even in the younger age group, has been the etiological factor in our cases which have been proved by surgical exploration and is the most likely cause in all.

Many men have stressed the causes of blebs and bullae and their relationship to spontaneous pneumothorax. Ornstein and Lercher[1] felt that spontaneous pneumothoraces were due to the development and rupture of emphysematous blebs in the visceral pleura. The blebs are produced by the rupture of the elastic fibres of the sub pleura alveoli into the alveolar layer of the pleura, by the forcing of the air from the bases of the lung into the apices of the upper lobes during severe coughing or the Val salva maneuver (straining against the closed glottis). This forcing of air into the upper lobes occurs more frequently in the young adult male, as in competitive sports, and may account for a higher incidence in males. This formation of blebs and bullae may occur in lungs free from disease or in peripheral sub pleural scar tissue resulting from previous pneumonitis, pneumonia, abscess, or tuberculosis.

In differentiating blebs from bullae, when a bleb is formed the lung is separated from the pleura by interstitial emphysema, the greater part of its wall consisting of attenuated visceral pleura. In bullae, the pleura retains its connection with the lung parenchyma and does not take part in the formation of the bullous wall.

Hayashi[2] described a simple method of formation of the check-valve mechanism. He demonstrated a valve between the bleb and the adjacent narrowed alveoli. There was a small opening between the elastic fibres leading into the bleb and a larger opening below

in the ceiling of the alveoli. The air entered from this space through the small opening into the bleb where it was trapped by this narrow opening (See figures 1, 2 and 3).

Kjaergaard[3] feels that the communicating air passage in the emphysematous lung are usually not valvular but free and wide. Emphysema is a pathologic condition due to fragility of the elastic

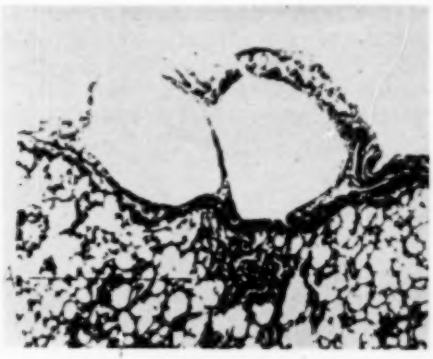

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 1: Two emphysematous blebs found in a case of bilateral spontaneous pneumothorax illustrative of the concept of the development of the blebs on a congenital basis. (A) indicates the area of congenital lung tissue. (After Schmincke, Beitr. z. path. Anat. U. Z. allg. Path.).

Figure 2: A drawing of an emphysematous valve bleb magnified 5 times its original size. To the right of the mid portion of the bleb one can see a respiratory bronchiole running obliquely up towards and opening into the bleb. (After Kjaergaard: Acta. Med. Scandinav. Supplement 43, 1932).

Figure 3: Photomicrograph of the communicating bronchiole to the same bleb as shown in Figure 2 magnified about 30 times. The emphysematous lung tissue above the bronchiole forms a tongue shaped flap capable of functioning as a valve. (After Kjaergaard: Acta. Med. Scandinav. Supplement 43, 1932).

tissue in the alveolar septa together with rupture of alveolar walls and confluence of alveoli. However, valvular opening may occur, and he demonstrated a check-valve mechanism between the distal bronchus and the emphysematous bulla. He described two types where the bullae are under tension, one where scar tissue in the base of the bulla maintains the check-valve mechanism, and one in which scar tissue was not necessary.

The larger bronchi may also produce giant valvular cysts. These result from defects in the wall of the bronchus. Check-valve mechanisms from granulation tissue or scar tissue may cause

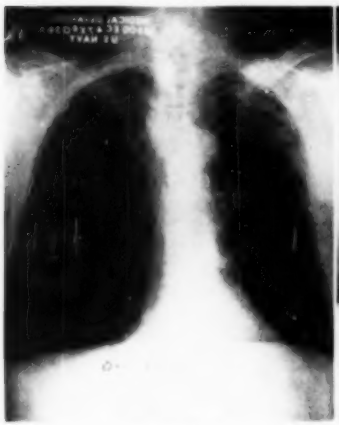

FIGURE 4

FIGURE 6

Mr. J.O. (Figures 4, 5 and 6), age 61, was flying east in November 1947, at an elevation of 14,000 feet, when he noticed shortness of breath, which required oxygen for relief. There was no chest pain. This dyspnea became progressively worse, and he returned to the West Coast. X-ray inspection revealed the mediastinum to be pushed to the left and some adhesions were visible in the right apex. A tension bulla was suspected and a needle was introduced to determine whether we were dealing with a spontaneous tension pneumothorax or a tension bulla. A small pneumothorax was produced, making the definite diagnosis of a tension bulla. Thoracotomy was then performed, using a right lateral incision. When entering the pleural cavity a large tension bulla was seen to come off the periphery of the right middle lobe. On opening the bulla, small leaks were seen in its base, numbering roughly twenty. The pathology was removed by clamp methods and the lung sutured. There was no evidence of tuberculosis in this lobe. However, in the upper lobe, healed tuberculosis was evident and many small bulla were seen on its surface. These were treated by Nissons[7] procedure. The pleural cavity was closed with two catheters, which were connected to water seals. The patient was ambulatory in five days. His convalescence was complicated by a single pulmonary embolus, with complete recovery.

such cysts to expand to tremendous size and to rupture, thus producing spontaneous pneumothorax. These are mainly congenital in origin and are probably the most common cause for spontaneous pneumothorax in infants and children.

Brock[4] described "leaky lungs or porous pleura" in which there are minute alveolar leaks through which the air escapes from the lung. In these cases no ruptured bullae or blebs can be demonstrated but when the lung is submerged under saline multiple leaks are apparent. There may be a congenital pleural defect where the elastic supporting tissue is defective in quantity and quality, which may crack with minimal trauma, allowing air to escape from the lung. (See figures 7, 8 and 9).

In lobular or segmentally localized emphysema with bulla or bleb formation there is a destructive process located between the bronchioles and the visceral pleura (between the bronchioles respiratoris and the chest wall), in contradistinction to bronchiectasis, where the pathological process lies mainly in the secondary and teritary bronchi. At surgery these lungs are voluminous and often do not collapse when the rib cage is opened if large un-

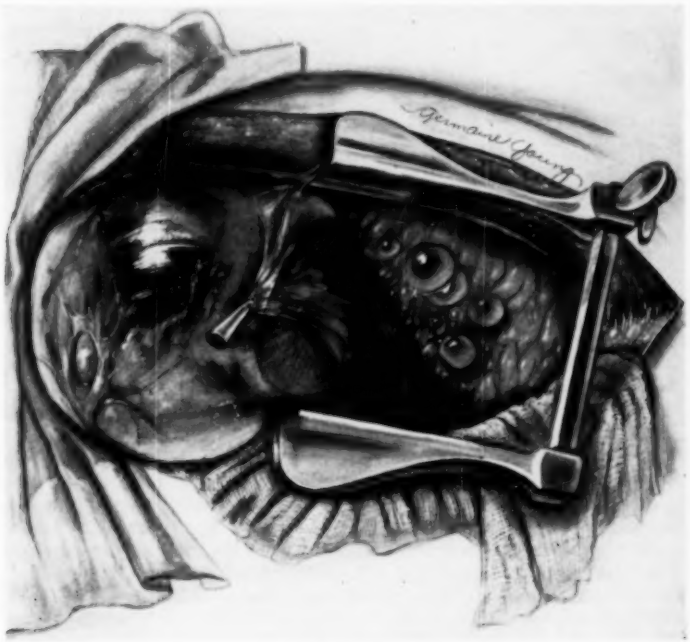

FIGURE 5

ruptured bullae are present. The lung is pale and avascular. Blebs and bullae located sub-pleurally are whitish and of tissue paper thinness. Without rupture they may be space-consuming and interfere with pulmonary and cardiac functions, requiring surgical removal for maintenance of life. The pathology may be lobar or segmental, or in some cases multiple bullae may be present numbering in the hundreds over the entire surface of the lung. (William Snow Miller[3] thought that possibly this condition could be caused by embolus or occlusion of the bronchial artery to the segment involved, thus causing destruction of the elastic structure of the

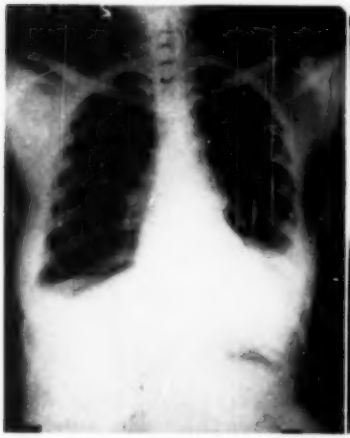

FIGURE 7

FIGURE 9

The following case illustrates congenital weakness of the visceral pleura classified by Brock[4] as "leaky lung or porous pleura."

B.B. (Figures 7, 8 and 9), colored female, age 36, entered the hospital on August 31, 1948 with the complaint of pain in the epigastrium and upper back for one week. The patient had always been well until this entry. There was no known tuberculous contact.

Physical examination was negative except: There were signs of hydropneumothorax on the right. Blood pressure 170/90. Roentgenograms of the chest confirmed the diagnosis of right-sided partial hydro-pneumothorax. Mantoux negative in all dilutions. Coccidioidin negative. (Guinea pig autopsied at the end of 6 weeks was negative). Bronchoscopy revealed a normal tracheo-bronchial tree. Aspiration revealed a clear amber fluid, with a differential cell count of 97 per cent lymphocytes.

Repeated aspirations of fluid and air failed to keep the lung expanded. Because of the persistence of her pneumothorax, on February 10, 1949 a right thoracotomy was performed. A lateral incision at the level of the 5th interspace was used and carried down to the rib cage. The pleural cavity was entered through the 5th interspace and the ribs mechanically

lobe or segment). Spontaneous pneumothoraces occur in those blebs or bullae in which there is a check-valve mechanism. The bleb or bulla enlarges and thins out so that it cannot further resist increased pressure, or there is sufficient tension to obliterate the blood supply to portions of its wall, resulting in necrosis and rupture.

In a large proportion of the cases of a single spontaneous pneumothorax the rupture of the bleb cures the patient for as it ruptures the walls fall in, sealing the multiple small fistulae. In recurrent spontaneous pneumothorax the other attacks may come from rupture of other blebs, or may be due to intermittent leaking

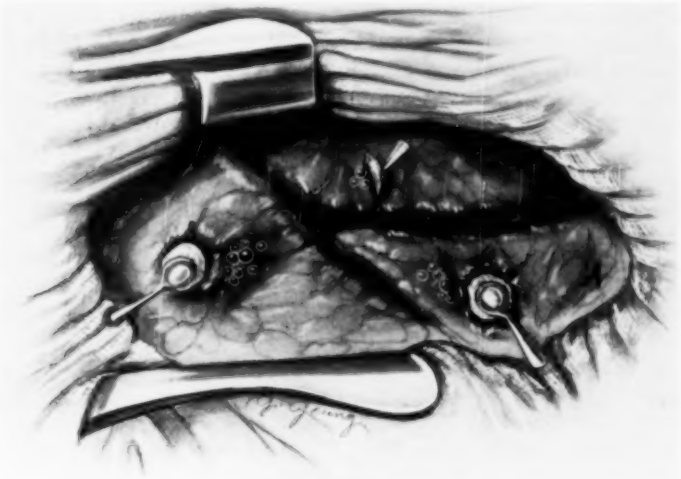

FIGURE 8

retracted without resection of a portion of the rib. The lung was found to be roughly 30 per cent expanded and no blebs or bullae were visible in any portion of the lung. When positive pressure was exerted on the lung by the anesthetist in an effort to expand it, radiating cracks appeared in the pleura over the surface of the lower middle and upper lobes. When the pleural cavity was filled with fluid a stream of bubbles was emitted from these cracks. A biopsy was taken of the lung and visceral pleura and "no pathology" was reported by the attendant pathologist. Two catheters connected to waterseals were used to drain the pleural cavity. Post-operative course was uneventful until the third post-operative day and her right lung reexpanded. At this time she developed a massive spontaneous collapse on the left, or opposite lung. This required catheter drainage and waterseal to control the tension.

This lung has since expanded also. Fortunately, the thoracotomy side had adhered and has remained adherent since surgery. The patient is now ambulatory.

of emphysematous bullae. In persistent spontaneous pneumothorax where the lung remains collapsed from two to three months or longer and shows no inclination for reexpansion, pathology may be due to one of the four following conditions:

1) The check-valve mechanism may be of such a nature that tension is built up and rupture reoccurs before the lung can re-expand, or multiple blebs or bullae rupture frequently enough to prevent reexpansion. (This was the most common cause of persistent collapse in our series, and is illustrated by the case of a 22 year old woman whose left lung had remained collapsed for two months and at thoracotomy the lingula was found to contain many bullae. While watching the effect of respiration on these, the largest ruptured. Following this, two smaller ones started to grow and subsequently ruptured. There were approximately 20 bullae present in the lingula. Following removal of the lingula the lung reexpanded uneventfully and she has remained free from attacks since 1942).

2) There may be intrapleural adhesions which are stretched by the collapse of the lung and which act as guy-wires, holding the fistula open and not allowing the lung to collapse completely and thus sealing the fistula. These leaks are often hard to demonstrate at surgery and it is wise to take all measures possible to find them before the adhesions are severed.

3) There may be fibrosis caused by scarring from previous disease about the opening into the base of the bleb or bulla, which will not allow healing of the fistula, or it may be a congenital cyst lined by bronchial epithelium. There is evidence that cavities such as produced by lung abscess have an ingrowth of bronchial epithelium after two months or more. When these rupture a lung may well remain collapsed indefinitely.

4) There may also be, in long standing collapse where fluid has formed or there has been bleeding of any consequence, the formation of a pleural membrane. This membrane is identical macroscopically and microscopically to that seen in organized hemothorax. It forms a fibrous envelope about the lung which does not allow reexpansion. In all cases where this is present it is extremely important to do a complete decortication of the lung, diaphragm, and chestwall, so as to allow reexpansion and return of the lung to maximum respiratory function.

These bullae and blebs are altered by anything increasing pulmonary pressure, such as high elevation, airplane travel, severe coughing from bronchitis and asthma, and the Val salva maneuver.

Differential diagnosis between spontaneous pneumothorax, tension cysts of the lung, and giant bullae is often difficult. Cases are reported where bilateral emphysematous bullae have been mis-

taken for bilateral spontaneous pneumothorax and vice versa. If there are lattice-like structures present in the x-ray film, one may be suspicious of giant bullae. Fluid levels on the roentgenogram do not help as they may occur in either condition. The needling of the area becomes necessary to make the differentiation at times. This may be a dangerous procedure unless one is prepared for all eventualities, as tension cysts and bullae are formed also by check-valve mechanisms. When the needle is introduced one may create a tension pneumothorax and complicate a case already in poor respiratory balance from the large space-consuming cyst. When needling is contemplated, a thoracic surgeon should be available as well as such equipment as catheter and water trap. Thoracotomy may become a necessary emergency procedure if the tension pneumothorax becomes severe but it is to be remembered that thoracotomy is the procedure of choice in the treatment of either a tension cyst or bulla. The needling is especially dangerous in infants so all precautions should be taken. However, in giant cysts and bullae needling may be the only and a necessary method of differentiation, as one does not wish to undertake thoracotomy in most cases of spontaneous pneumothorax without first trying more conservative methods. (See figures 4, 5 and 6).

Intrapleural pressure readings will reveal an indication of the size of the fistula involved by the rapid return of pleural pressures to positive after air has been removed.

Bronchoscopic examination usually shows little but may reveal tortion and dislocation of the position of the normal segmental orifices. Bronchograms may reveal, especially where there are large space-consuming bullae, compression of the surrounding secondary and tertiary bronchi and may also show unsuspected bronchiectasis.

The treatment of simple and single spontaneous pneumothorax is usually by conservative methods, such as bed rest, adjusting intrapleural pressures, oxygen inhalation, cough sedation, etc., until the lung has completely reexpanded as shown by x-ray film. If tension pneumothorax persists, a catheter inserted in the second interspace anteriorly and connected to a water trap bottle will usually control the pressures sufficiently for the fistula to close. Only in extreme cases, where there is an exceptionally large fistula, will exploration be necessary. Alexander[6] has pointed out the fact which is also applicable to persistent forms of spontaneous pneumothorax that it is better not to try for too rapid expansion of the lung, but to allow time for the visceral opening to close by using only the water seal method, and not active suction.

The treatment of recurrent and persistent spontaneous pneu-

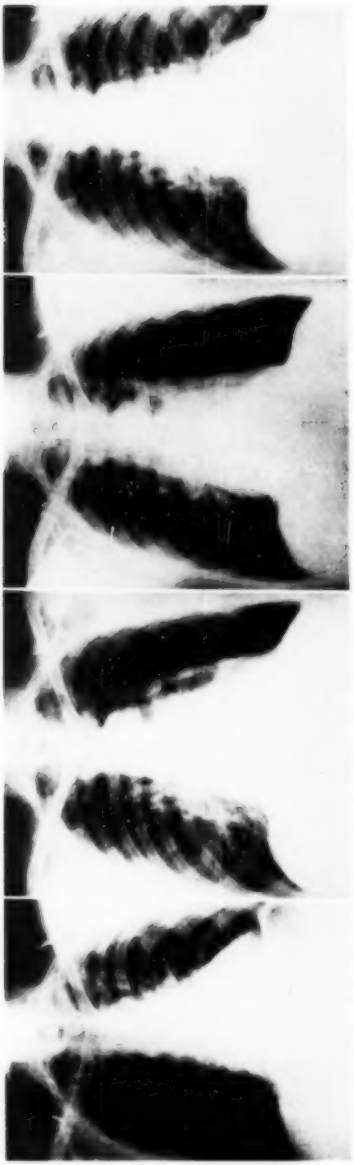

FIGURE 14

FIGURE 12

FIGURE 11

FIGURE 10

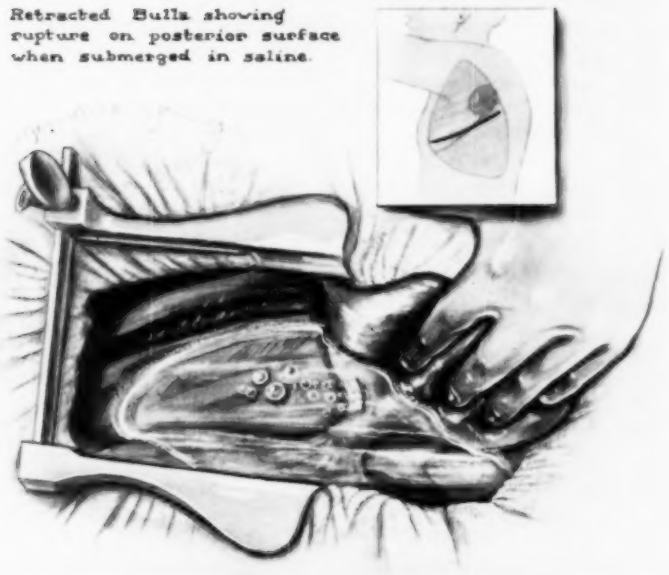

FIGURE 13

The following case is being submitted as an example of recurrent and persistent spontaneous pneumothorax treated by thoracotomy and illustrating the most common etiological factors and the surgical procedures necessary for its correction.

M.L.S. (Figures 10, 11, 12, 13 and 14), 72 year old white male was seen first on April 24, 1947 complaining of shortness of breath, slight cough, and dyspnea. An x-ray film taken by his private physician had revealed a spontaneous collapse of the left lung. There was no previous history of similar episodes and no known contact to tuberculosis. His Mantoux was positive and x-ray films of his chest revealed an old parenchymal lesion in the visible lung fields. Intrapleural pressure readings taken were 0 minus 10. Following cough with a needle in place 0 minus 3. As there was no evidence of tension, the patient was placed on strict bed rest and cough sedation. Cardiac studies revealed myocardial embarrassment and coronary sclerosis. The patient remained in bed for a period of six weeks and following x-ray examination which revealed complete expansion of this lung, was allowed up and returned to work. His course was uneventful until October 1948 when he had a similar attack. X-ray films again revealed a collapse of his left lung. This time, however, he developed a definite tension pneumothorax. Thoracotomy was advised but the patient did not acquiesce until March 7, 1949 and then only because his dyspnea was so marked that he was forced to sit up to sleep. Conservative measures other than catheterization and water seal had been tried and failed in reexpanding the lung, or in permanently relieving the tension. Bron-

mothorax is more complicated. Chemical irritation of the pleural surfaces with the aim of causing pleural symphysis has been advocated in the past. Material such as gominol in oil, iodized oil, blood, silver nitrate solution, hypertonic glucose solution, talc, or combinations of the above have been used. These chemically irritating substances often make the patient extremely ill with fever, pain, etc. For best results in this procedure it is necessary for the lungs to be expanded so that the two pleural surfaces are in contact. If used with the lung in a collapsed state, they may produce so severe a reaction that there is the formation of a dense adherent membrane that is almost impossible to remove by decortication. In cases of tension bullae, it may cause an adherent pleura and prevent spontaneous pneumothorax, but the underlying lung pathology may continue, resulting in large space-consuming bullae which will eventually require thoracotomy.

It is the authors opinion that this method is applicable only where thoracoscopy has revealed a large number of sub-pleural blebs often numbering in the hundreds, or when one is faced with leaky or porous lungs where there is a congenital weakness of the pleura and supporting structures.

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choscopy revealed a normal visible bronchial tree. On March 7, 1949 a thoracotomy was preformed, using a left lateral incision at the level of the 5th interspace. Incision was carried down to the rib cage and the pleural cavity was entered through the 5th interspace without resecting any portion of the rib. On entering the pleural cavity, the lung was found to be collapsed tightly against the mediastinum except for the pectoral segment of the upper lobe. This was adherent to the chest wall at the level of the 4th rib posteriorly by band adhesions and a large emphysematous bulla was adherent to the chest wall in this same region.

This bulla was connected to the same segment of the lung. It measured 8 cm. in diameter and was thin-walled and expanded and contracted with respiration. No ruptured area was apparent on the anterior surface and it was not until the pleural cavity was filled with saline and the patient was tipped into mild Trendelenburg position so as to cover the bulla that the leak was demonstrated. No other leaks were found. All adhesions were severed from the chest wall freeing the lung in its entirety. As the bulla was purely peripheral, and as it was found when it was opened that there were multiple small fistulae leading into it from the lung periphery, clamp resection and removal of the pathology was decided upon. This was done uneventfully and the lung expanded. Two catheters connected to waterseals drained the pleural cavity. The patient's convalescence was uneventful. He was ambulatory in five days and returned to work within a period of 3 weeks. Subsequent follow-up has revealed the lung to be completely expanded. The follow-up period, however, has been too short to draw final conclusions as to cure. The pathological report was that of emphysematous bulla and no evidence of tuberculosis was demonstrated, macroscopically or microscopically.

Thoracoscopy was not used by the author in his cases of persistent spontaneous pneumothorax but would seem to be a useful procedure. It is simple enough to do and in this condition would not carry many of the complications of its use in active pulmonary tuberculosis. By it one may be able to plan a better surgical correction at thoracotomy and in some it may yield sufficient information so that thoracotomy may not be necessary.

However, in the vast majority of cases of recurrent and persistent pneumothorax thoracotomy is indicated. It gives the most direct approach to the actual pathology causing the disability. One would not attempt to fix a leaking auto tube by sealing it to the tube casing. The author has been able to obtain sufficient exposure in all of his cases by rib spreading without resection of any ribs. This makes a stronger chest wall with less intercostal pain postoperatively. In 10 cases subjected to thoracotomy there

FIGURE 15: Represents the surgical findings on a man who had a pneumatocele at the right apex and who on being subjected to speed-flying developed spontaneous collapse of the right side; this remaining collapsed for two months. The reasons for persistence of collapse are illustrated in the diagram.

has been no mortality and all of the patients have been ambulatory within one week.

On opening the thoracic cavity one can in most cases readily see the reason for the persistence of the collapse. In some, however, it is not so obvious and in these it is wise not to sever adhesions until the leak is found. By filling the pleural cavity with saline and by changing the position of the patient, the formation of bubbles will show a leak being kept open by adhesions acting as guy-wires, and multiple leaks may be demonstrated. When all have been located one must do a complete pneumonolysis freeing the lung in its entirety followed by the necessary surgical closure of the defects. Where large blebs and bullae exist, these must be removed, either by perpiheral clamp method with sutures, segmental resection, or lobectomy. It should be the aim of the surgeon to preserve as much good lung as possible for the best pulmonary function. As the further formation of similar pathology and emphysema is always a possibility, conservation of as much

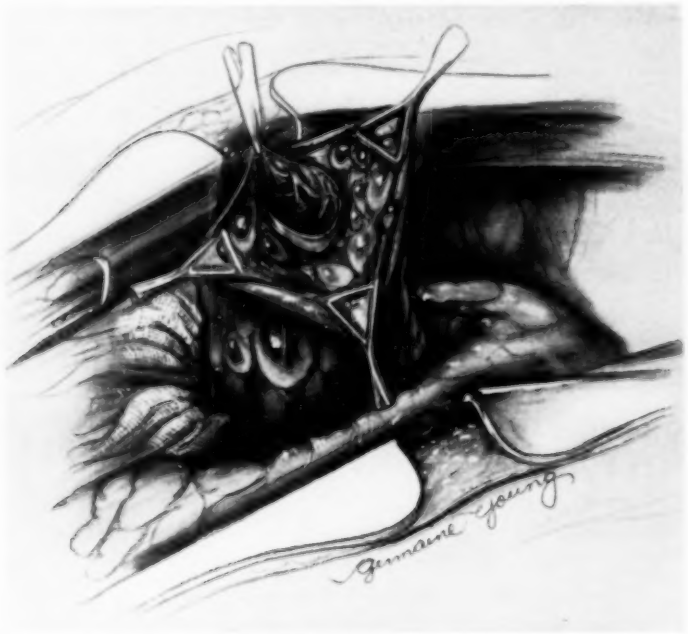

FIGURE 16: Represents a woman, age 30, who had had three recurrences of her right pneumothorax. At thoracotomy multiple blebs were seen at the apex of the right upper lobe. A segmental resection working from the periphery of the larger bronchi was done. Convalescence has been uneventful.

good lung as possible is imperative. One often sees one or two large bullae and many small ones. Nissons[7] operation of opening the small bulla and suturing the base, or simply putting a suture through the base of the bleb as used by Blades,[8] will prevent these from enlarging and rupturing.

Brewer[9] emphasizes the importance of doing a decortication of the collopsed lung at the time of thoracotomy. He states there is commonly a tough membrane similar to the membrane seen in hemothorax that must be peeled off the lung, diaphragm, and chest wall to get maximum return of expansion and pulmonary function. This membrane has not been present in any of the authors cases. However, the necessity of decortication can readily be determined at thoracotomy and is an important step to be kept in mind. (See figures 10, 11, 12, 13 and 14).

The aim of thoracotomy, therefore, is to correct the defect in lung tissue as simply as possible, conserving the good lung, removing all adhesions, and constricting membranes so as to allow unimpeded expansion of the lung and so obtain as normal pulmonary function as possible. The author would like to stress the fact that thoracotomy itself produces sufficient pleural resection to produce a good pleural symphysis as well as correction of the pathology in the lung. Where it has been necessary to reenter the pleural cavity following previous thoracotomy, one is impressed by the pleural adherance.

SUMMARY

This has been a study of 86 cases of non-tuberculous and non-traumatic spontaneous pneumothorax seen during the last five years. Such spontaneous pneumothoraces are a common clinical entity; recurrences are fairly frequent; non-expansion of the lung is more rare. When external violence and tuberculous disease, etc., are ruled out, the cause is considered to be the rupture of blebs or bullae. This was proved in 10 cases where surgical exploration was done for persistent collapse.

A check-valve mechanism causing tension in such blebs is discussed. Illustrations demonstrating this mechanism are shown.

These blebs and bullae, increasing in size under tension may cause respiratory embarrassment by encroaching on surrounding tissue, or may rupture due to interference with blood supply to the bleb wall, or by excessive intrableb pressures and produce pneumothorax. In most cases, where a bleb ruptures, the walls seal the fistula and the lung expands uneventfully with disappearance of the bleb. In a few cases, however, guy-wire intrapleural adhesions, fibrosis from pleural disease, a pleural membrane, or, in the majority of cases, a check-valve mechanism

which maintains a continuous or intermittent fistula, keep the lung collapsed, producing persistent and even tension pneumothorax. Such pneumothoraces must be differentiated from tension cysts of the lung and giant tension bullae, and the dangers of needling these are emphasized.

Treatment of spontaneous pneumothorax is also discussed emphasizing the limited indicators for poudrage, and the necessity for and the good results of exploratory thoracotomy in persistent pneumothoraces.

It is the author's opinion that the cause of persistent and recurrent spontaneous pneumothorax lies in the bronchioles and alveoli in the great majority of cases. Attempts at pleural symphysis with blood, silver nitrate, etc., will usually not give good results. Surgery is the method of choice.

RESUMEN

Esta es una presentación de la etiología y tratamiento quirúrgico del neumotórax espontáneo no tuberculoso debido a ruptura de las vesículas. El neumotórax espontáneo es una entidad clínica común; recurrencias en el mismo paciente son menos comunes; la no expanción en estos casos es más rara.

En la mayorá de los casos cuando una vesícula se rompe, hay un cambio en la mecánica del pulmón y éste se expande tranquilamente con la consiguiente curación. Pero en unos pocos casos, un mecanismo de impedimento mantiene una fístula continua o intermitente y el pulmón permanece colapsado produciendo un persistente y hasta tenso neumotórax. Entonces la toracotomía exploradora es necesaria.

Hayashi fue el primero en describir una válvula obstáculo (check-valve) entre la vesícula y los alvéolos adyacentes. Kjaergaard demostró un mecanismo de obstáculo valvular (check-valve mechanism) entre los bronquiolos distales y la vesícula enfisematosa.

Estas vesículas, aumentando de tamaño bajo la tensión, pueden causar dificultad respiratoria untruyéndose en los tejidos circundantes o pueden romperse debido a la interferencia en el aflujo de sangre a la pared de la vesícula o por exesiva presión intravesicular, y produce un neumotórax. Estas vesículas son alteradas en su tamaño por cualquier cosa que aumente la presión intrapulmonar tal como ascenso progresivo, viaje aéreo, bronquitis, asma, etc.

Láminas ilustrativas de estos mecanismos de obstrucción valvular (check-valve mechanism) y en una serie de seis casos en los cuales la toracotomía exploradora fue necesaria serán demostrados.

Una película sobre una toracotomía por neumotórax espontáneo de tensión persistente, demostrando la vesícula y su corrección quirúrgica será proyectada.

Es la opinión del autor que la causa fundamental de ésta condición en estos casos de neumotórax espontáneo persistente y recurrente está en los bronquiolos y alvéolos. Ensayos con nitrato de plata, etc., en los casos de sinfisis pleural sangrante no darán uniformemente buenos resultados. La toracotomia exploradora está indicada.

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Discussion

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The vast majority of patients with spontaneous pneumothorax of nontuberculous etiology require no special treatment or only one or two aspirations of air. Pleural irritants may be employed in some cases of *recurrent* pneumothorax provided one is sure that the visceral and parietal pleura can be brought temporarily in apposition.

Surgical treatment is advisable in a small percentage of patients with pneumothorax due to ruptured emphysematous blebs. The chief indications for operative intervention are (1) *persistent* pneumothorax and (2) localized blebs of considerable size in which resection is advisable. The lung may fail to completely re-expand either because of continuation of leakage of air from the ruptured bleb or because of the formation of a restrictive membrane over the visceral pleura. Such a membrane may be present even when appreciable pleural fluid has not been observed. If markedly negative intrapleural pressure is present, the failure of re-expansion is to be attributed to a membrane over the pleura rather than continued leakage of air from the lung, provided that re-inflation of the lung is not prevented by intrabronchial or intrapulmonary factors. The negative intrapleural pressure which develops in such cases favors recurrence of rupture of the same or another bleb. In some cases a visceroparietal pleural adhesion is a factor in the maintainence of the chronic pneumothorax. Thoracoscopic division of such an adhesion is then indicated.

The treatment of chronic pneumothorax due to ruptured emphysematous blebs is directed at obtaining pulmonary re-expansion. Since diffuse emphysema of varying degree is usually present in these patients, the preservation of pulmonary function is of greatest importance. The results of therapy must therefore be evaluated from the standpoint of respiratory function, and not merely on the basis of radiographic evidence of re-expansion of the lung. The importance of pleural factors in pulmonary function has been amply demonstrated in recent years. Diffuse pleural symphysis which restricts lung motion is undesirable. The therapeutic aim in chronic pneumothorax is to obtain fusion of the visceral and parietal pleura without the formation of a restrictive membrane. Therefore irritating substances which evoke a long-standing fibrosis of the pleura are contraindicated. Also, when surgical treatment is undertaken thoracotomy should be performed in such a way as to minimize the disturbance of the thoracic cage.

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It is fortunate for all of us that Doctor Crenshaw's excellent paper was included in this program. Although thoracic surgeons have been aware for some years of the necessity for surgery in this condition, there is a rather surprising paucity of reports in the American literature. Steele, and Hethirngton and Spencer advocated the promotion of pleural adherence by poudrage and by general injection, but until the paper of Brewer at the last meeting of the American Association for Thoracic Surgery, and the present report, little has appeared on the comprehensive surgical attack. Brock in England has presented the most complete survey, with a report of 71 personally treated cases of recurrent or persistent pneumothorax.

Our own experience and opinions so closely parallel those of Crenshaw that reiteration would be superfluous on most points. We have seen almost the same number of cases of simple spontaneous pneumothorax, though over a longer period, and have resorted to surgery in but eight instances; two cases having had wedge resection, two lobectomies, three closed thoracotomies, and one cauterization. Poudrage has not been used, though we concede it might be feasible in certain selected cases.

All but two of our patients had preliminary thoracoscopy, a procedure we feel should preferrably be done in every questionable case in order to plan a definitive surgical attack. I wish to report cases illustrating the advisability of the procedure.

The first is that of a 54 year old aluminum plant foreman who was hospitalized elsewhere for three months before we saw him.

Apparent reexpansion has been effected on several occasions, twice with an indwelling needle and water trap, only to have the pneumothorax recurr within a day or two. Obviously a small but persistent fistula was present.

At diagnostic thoracoscopy, performed after the patient had been referred to us, an isolated fistula about one millimeter in diameter was clearly seen on the inferior surface of the left upper lobe just within the fissure. No blebs were present, although it was felt an isolated one had been present at the site of the leak. Careful cauterization of the fistula with the live cautery resulted in its closure and the prompt reexpansion of the lung, thus obviating the open thoracotomy first felt to be indicated.

The second case is that of a 14 year old boy apparently in excellent health until he was seen by us in consultation with what appeared to be simple spontaneous pneumothorax on the right. This responded to conservative management, but recurred one month later. Again satisfactory reexpansion occurred, the lung appearing normal. However, two months later x-ray inspection showed shadows suggestive of bullous emphysema in the right lower lobe. About a month after this development the patient was readmitted to the hospital in his third episode of right-sided pneumothorax. Conservative measures, including an indwelling cannula, failed to relieve dyspnea; subcutaneous and mediastinal emphysema ensued and were not relieved by supraclavicular and suprasternal incisions. X-ray inspection three days later, on the day of death, showed another spontaneous pneumothorax to have occurred on the left. The patient died about six months after the first episode of spontaneous pneumothorax. Autopsy showed both lungs to be almost completely replaced by cyst formation with fibrosis, with emphysematous blebs studding the entire pleural surfaces. The pancreas was about one-fourth normal size and showed marked alteration of the normal architecture, notably a diffuse increase in connective tissue. This picture, however, differed from the usual findings in fibrocystic disease of the pancreas in that the pulmonary changes were decidedly atypical.

Thoracotomy was not performed in this case, nor was exploration. Had open operation been considered, preliminary thoracoscopy would have shown that thoracotomy would not only be ineffective but definitely contra-indicated.

We are in entire agreement with Doctor Crenshaw in using the intercostal approach when thoracotomy is necessary. We feel strongly that it should be the aim of every thoracic surgeon to return the thoracic cage to as near normal function as possible. This is always better achieved when ribs are not resected or divided.

Treatment of Psychiatric Tuberculous Patients*

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The purpose of this paper is to show that psychotic patients with pulmonary tuberculosis can be managed almost as well as the ordinary sanatorium tuberculous patient.

Until recently, an attitude of pessimism has prevailed in the literature. For example, Wicks[4] states, "Artificial pneumothorax treatments are given to all cases where the usual indications are present and where the patients would cooperate for these treatments. Phrenic nerve crushing as well as bilateral artificial pneumothorax have been performed in relatively few selected cases. It is rather doubtful whether any of the other more radical types of chest surgery (with the possible exception of intrapleural lysis) should be attempted in a tuberculosis mental unit."

A far more optimistic attitude has recently been propounded by Lambiotte, Washington and Bozalis,[7] who used practically every modality in their treatment of psychotic tuberculous patients.

On the basis of our own experience, we are in complete agreement with this approach but would carry it even one step further. Lambiotte, et al[7] state: "Major thoracic surgery should be reserved for those patients with a favorable prognosis for remission of their psychosis or for the ones who have made a satisfactory adjustment under maximum privileges and minimum supervision."

We feel that this approach is too conservative because we believe that the eradication of a tuberculous focus is, from a broader point of view, an end in itself. Even if the patient is to be hospitalized for the remainder of his life because of his psychosis, it is important to eliminate the hazard of tuberculous infection not only to himself but to other patients and to those who must take care of him. We have even seen a few patients whose psychosis remitted following collapse therapy and arrest of their pulmonary disease. Denying these patients the benefits of all modalities of collapse therapy is as wrong as denying a psychotic patient a gastrectomy for carcinoma of the stomach.

This report is based on experiences in the treatment of 125 psychotic tuberculous patients at the Veterans Administration Hos-

*Read before the joint meeting of the New Jersey Chapter of the American College of Chest Physicians and the Passaic County Medical Society, Valley View Sanatorium, Paterson, New Jersey, October 18, 1949.

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pital, Lyons, New Jersey, during the past three years. Sixty-two more patients were studied on the "Observation Service."* Of these, nine were found to have active lung disease and they were transferred to the Tuberculosis Service.

Every patient was reviewed by the Chest Board, which consists of the chief of tuberculosis service, chief of medicine, consultants in medical tuberculosis and thoracic surgery and the roentgenologist. The Chest Board reviewed each patient routinely on admission to the service and as many times thereafter as indicated.

In every case treatment was prescribed as if the patient were mentally well with one exception: We were more inclined to recommend collapse procedures because of the obvious difficulties in maintaining absolute bed rest.

Bed rest is one of the most important forms of therapy in tuberculosis but we had to compromise somewhat in this respect. Ninety per cent of our patients kept rest hours from 9 to 11 a. m. and 1 to 4 p. m. With this regime we had to be satisfied. But, this regime can be maintained only through the constant supervision of the nurses and psychiatric aides combined with an attitude of sympathetic persuasion. No matter how removed from reality these patients might be, most of the new admissions fall into this routine.

Maintenance of nutrition is of great importance in the treatment of tuberculous psychotics. At times, patients refuse to eat not only because of tuberculosis but also because of psychosis. Here again the same attitude of sympathetic persuasion is necessary. Occasionally a paranoid or catatonic patient will refuse to eat altogether. In such a case, stomach tube feedings are given daily until eating is resumed.

Most of our patients expectorate everywhere but in sputum cups. When they can be persuaded to use the sputum cup for a specimen, it is usually mixed with saliva, cigarette butts and various other sundry items. We, therefore, find it necessary to do gastric lavages on most of them. This is usually smeared and then cultured on petragnani medium if the smear is negative. At first, active restraint is necessary but after a while most patients undergo this procedure without objection.

In addition, all other methods used to demonstrate activity of a lesion have to be used. An elevated erythrocyte sedimentation rate is suggestive of activity but has not been of much assistance to us. The frequency with which the sedimentation rate was at

*The Observation Service is a 35 bed ward. Here, all patients discovered through repeated x-ray surveys to have questionable infiltrations are studied for varying periods. If the disease is found inactive, they are sent back to the Psychiatric Wards. If found active, they are transferred to the Tuberculosis Service.

variance with the remainder of the clinical picture is probably in line with the inconstancy of physiological responses in general in schizophrenic patients, whether tuberculous or not.

A low grade fever in the presence of an otherwise arrested state puzzled us on occasion. Wicks[4] states, "A large number of mentally ill patients showed slight rises of temperature without any evident organic disease and certainly without any evident abnormality in the parenchyma of the lung fields." Gottlieb and Lindner,[3] in an exhaustive study on 26 schizophrenic patients and 16 normal controls conclude, "Schizophrenic subjects are unable to comply normally with the homeostatic principles concerned with the regulation of heat. Their homothermic stability seems to have been replaced by a lower phylogenetic type of adjustment mechanism resembling poikilothermism."

Some of our observation cases were studied for many months. Review of x-ray findings showed that roentgenographically they had remained stable for periods of several years. Repeated sputum smears, gastric smears and gastric culture examinations were negative for tubercle bacilli, yet the graphic chart showed frequent temperature elevations to 100 and 100.4 degrees F. rectally. Likewise, there were cases that had clinically become arrested after varying periods of treatment who persisted in running a low grade fever from time to time.

Bronchoscopy contributes considerably to the diagnosis and treatment of chest diseases. However, we had to find a way of bronchoscoping the most hyperactive and uncooperative patient. This we accomplished by transtracheal anesthesia and sodium pentothal intravenously.

For many years, the British physicians,[2] have been using transtracheal anesthesia. More recently Harken and Salzberg,[1] used it in more than 1,000 bronchoscopies. This method of anesthesia requires only minimal cooperation on the part of the patient, consequently it was ideally suited to us in our work.

With the patient on his back and head hyperextended, the cricothyroid membrane is identified and the overlying skin and subcutaneous tissues are infiltrated with 2 per cent procaine hydrochloride. Following that, 5 cc. of 1 per cent Pontocaine are drawn up in a 10 cc. syringe and a 1 inch 18 gauge needle is attached. With this needle, the cricothyroid membrane is pierced and when air can be drawn back in the syringe it is safe to instill a few drops of pontocaine. This causes violent coughing during which the pharynx and larynx are anesthetized. At approximately 1 to 2 minute intervals 0.5 to 1 cc. of pontocaine are instilled in the same manner until local anesthesia is obtained. This is apparent when cough is markedly diminished or completely abol-

ished upon instillation of the drug. At each spasm of cough the needle must be pulled out quickly and pressure applied with gauze in order to prevent subcutaneous emphysema.

Intravenous sodium pentothal has always been considered contraindicated in bronchoscopy, yet we have used it with little difficulty. With good local anesthesia, reactions from the pentothal are infrequent. In 17 bronchoscopies with sodium pentothal anesthesia, there was only one minor reaction and here the laryngospasm lasted about one minute. If the glottic region is not traumatized and the scope passed quickly, the procedure is quite safe. However, one must always weigh in one's mind the urgency of the bronchoscopy as against the danger of laryngospasm and always be prepared to do an emergency tracheotomy.

Since we had no experienced "head holder" to assist the bronchoscopist we used the head rest of Jones. It is an incline plane, the base of which is 19 inches, the inclined portion is 16 inches and the back drop is 6 inches. This fits at the head of the table and it is padded and covered with leather. A nurse or an attendant holds the occiput at the proper level for the bronchoscopist. When the bronchoscope has passed the larynx the occiput is simply lowered about two inches.

Our psychiatric service did not approve of electric shock in the face of active pulmonary tuberculosis. However, it was occasionally necessary in order to quiet a hyperactive patient to the point where he might accept modified bed rest. In six such cases we used nonconvulsive frontal stimulation with some degree of success.

In none of the 33 pneumothorax patients of Bozalis,[7] in one of the 100 pneumothorax patients of Altshuler and Bailey,[6] and in only one of our 27 pneumothorax patients was it necessary to discontinue treatment because of the psychiatric condition. However, the results with pneumothorax were poor because in practically all of our cases the tuberculosis was of long duration. In only three patients was the disease arrested and the lungs allowed to re-expand. The fourth is still receiving refills. In the series of Leonidoff,[5] 72.71 per cent were ineffective. He can find no reason for these poor results and concludes that primary thoracoplasty would probably be the procedure of choice although in his series of 12 cases, he was not "very successful."

Streptomycin has been used in accordance with the indications recommended by the various Streptomycin Conferences of the Veterans Administration. We have of late been rather conservative in this treatment because of the ease with which tubercle bacilli can become resistent to this drug.

We have completed 11 thoracoplasties since June, 1947. The psychiatric prognosis did not influence us in our selection of cases.

The operations were all performed by our consultant in thoracic surgery, Dr. George N. J. Sommer, Jr. Each patient was bronchoscoped before surgery.

In only one case did the psychiatric condition trouble us but even here we were eventually able to operate on this patient with success. Because of its unusual interest this case is reported in detail.

A.T. is a 27 year old World War II Veteran, admitted to Olive View Sanatorium on November 27, 1946 with a diagnosis of caseous pneumonic tuberculosis in the left lung. He received pneumothorax therapy at that hospital but collapse was inadequate so it was abandoned and thoracoplasty was recommended. He left the hospital without permission and before the operation could be done. Nothing more is known about him until September 23, 1947 when he was picked up in New Jersey and taken to the Camp Kilmer Station Hospital and subsequently transferred to Lyons Veterans Hospital on September 24, 1947.

On admission to this hospital he was extremely hyperactive and assultive. He was disoriented and unable to give any history. He was childlike in manner and deportment and displayed behavior indicating reaction to active hallucinations. He had no insight into his condition.

This was our first experience with an acute psychotic patient where the thoracoplasty was considered life saving. Because of the acute state of the tuberculous process electric shock was contraindicated.

He began having blood streaked sputum on November 10, 1947. A phrenic crush was done on the left side four days later. The next day the streaking stopped. Dr. Sommer performed a first stage thoracoplasty on November 21, 1947. Postoperatively, to our surprise, the patient became quiet and cooperative. We had no difficulty keeping him in bed. On November 27 he had a 400 cc. hemorrhage with spread of his disease to the left lower lung field. Streptomycin was started. Encouraged by the patient's acceptance of the first stage, two more stages were completed with the same quiet postoperative course.

Since that time we have operated on other hyperactive patients and had no difficulty at all postoperatively. During this period these patients were all "specialed" by psychiatric aides trained in tuberculosis care. Here also the same attitude of friendly persuasiveness was of great importance.

Dr. W. A. Loeb,[8] of our hospital, in the Veterans Administration Bulletin of 1938 stated: "It appears that satisfactory operative results in psychotic patients depend upon essentially the same care as is attendant upon the surgery in non-psychotic patients, and in recognizing and meeting the needs of the individual case. The supposition that surgical hazards become intensified in psychotic individuals is unjustified and groundless. There are no significant complications immediate or late in psychotic patients. This being concluded from the review, it follows that there can be no sound basis for the seemingly prevalent assumption that a psychosis contraindicates or materially increases the risk of major

surgical collapse in tuberculous patients." Dr. Loeb tells me that in 1938 he performed two thoracoplasties on psychotic tuberculous patients at the Veterans Administration Hospital in Augusta, Georgia. This was considered radical at that time.

Tuberculosis may bring about a toxic condition which in itself is the cause of mental confusion. We had two cases of probable toxic psychoses in which the psychoses remitted completely following the clearing of their tuberculosis.

A.K. is a 30 year old white male admitted to this hospital June 30, 1947. About two weeks before admission, he became seclusive, incoherent and confused. At about the same time it was noted that he had lost 25 pounds in two weeks, had been having night sweats and developed a severe productive cough. On admission, he was poorly oriented in all spheres. His attention was easily distracted and his memory was faulty. He was in a constant state of emotional tension. He was quite preoccupied with his own thoughts and had many delusions such as misidentifying persons and continually claiming that he had been injured in various ways. An x-ray film of his chest showed an extensive caseous pneumonic lesion involving almost the entire left lung. He had a severe productive cough and his temperature spiked to 102 degrees F. The Chest Board considered pneumoperitoneum and a left phrenic crush as the only form of collapse suitable at that time. This was done. As the tuberculosis improved, cough diminished, temperature came down slowly and appetite increased, the mental symptoms gradually cleared. Two months after admission this patient's psychosis was in complete remission. He had gained 30 pounds and his cough had nearly ceased.

The other case (J.H.) was a 22 year old white male. His onset of symptoms date back to December 1945, a year and a half before his admission to Lyons. A routine chest plate in May 1946, revealed evidence of disease in the left upper lung field which proved to be active with positive sputum. Pneumothorax and pneumonolysis were ineffectual in controlling the lesion. In November 1946, pneumoperitoneum and left phrenic crush were done. This also was not effective since the disease remained active. First stage thoracoplasty with removal of three ribs was done on June 2, 1947. Ten days later, he showed signs of mental disturbance for which he was transferred to this hospital.

On admission he was sullen, glowering, resentful, hostile and failed to establish rapport after concerted effort. Orientation was approximate but he could not account for the incidents leading to his transfer. Judgment and insight were grossly defective. He had productive cough, daily temperature elevations up to 102 degrees F. and his appetite was poor. Second stage thoracoplasty was done August 1, 1947 following which he became quiet, more cooperative and better oriented. Ten days later he reverted partially to his former state. After the third stage on August 15, 1947 he was quiet and cooperative but the hyperactive symptoms returned again for 20 days. His psychosis began clearing after these first three weeks and there was a complete remission of mental symptoms. It was possible to transfer him to a regular tuberculosis hospital on February 6, 1948.

These two cases illustrate the importance of aggressive tuberculosis therapy even in the face of frank psychosis. One cannot

TABLE I

	Diagnosis	Mental Condition Before Thoracoplasty	Mental Condition Immediately After Each Stage	Course Following Thoracoplasty
J.H.	Toxic Psychosis	Hyperactive, Disoriented, Confused, Negativistic, Assaultive	1st Stage—Became Psychotic 2nd and 3rd Stages—Complete remission	Transferred to Castle Point as non psychotic for further treatment of tuberculosis
M.W.	Psychosis with Cerebral Arterio-sclerosis	Withdrawn, Seclusive, Flat Affect, Cooperative	No Change	No Change
A.T.	D.P.C.	Hyperactive, Assaultive, Profane, Untidy, Destructive, Confused	1st Stage, 2nd Stage, 3rd Stage } 10 days—Oriented Quiet—Stayed in bed	Slow improvement in past year—tidy, less destructive, not assaultive
L.G.	D.P.C.	Mute, Seclusive, Disinterested in Ward Routine	More Responsive, More Interested in Ward Routine between stages and for one month after 3rd stage.	Lapsed back into seclusion—no improvement since beginning
G.B.	D.P.P.	Assaultive, Periods of Disorientation, Easily Disturbed, Negativistic	Quiet, Cooperative, Complete Orientation throughout entire operative period and for six months thereafter.	Six months after last stage reverted to pre-operative state

C.D.	D.P.P.	Untidy, Destructive, Uncooperative, Profane, Restless and Disoriented	1st Stage—4 days 2nd Stage—Entire Period 3rd Stage—10 days	Cooperative Quiet Friendly	Improved Slowly—Cleaner Habits, Ridiculous Facetiousness, Less Hyperactive, More Oriented
P.S.	D.P.C.	Degenerated, Assaultive, Mute, Seclusive, Soiler at times	1st Stage 2nd Stage 3rd Stage	More Cooperative, More Alert —48 hours post-operative	No Change
W.C.	D.P.H.	Mute, Seclusive, Untidy, Quiet, Uncooperative	1st Stage 2nd Stage 3rd Stage	5-6 days	Responded Somewhat Rational Cooperative	Reverted back to Pre-operative State
M.C.	General Paresis	Mute, Easily Disturbed, Negativistic	1st Stage 2nd Stage 3rd Stage	10 days	Responded Cooperative Appetite Improved	Reverted back to Pre-operative State
P.K.	D.P.H.	Quiet, Fairly Cooperative, Flat Affect—Disinterested in Ward Routine, Occasional Periods of Assaultiveness	1st Stage 2nd Stage 3rd Stage	and for one month after 3rd Stage Cooperative, Affect Improved, More Interested		Reverted back to Pre-operative State
J.K.	D.P.P.	Periods of Mutism, Hallucinations, Uncooperative	1st Stage 2nd Stage 3rd Stage	Complete Remission During Stages and for $2\frac{1}{2}$ months following		Slowly Returning to Pre-operative State

always be sure that a psychosis is toxic in origin until it remits following improvement in the patient's tuberculous condition. It would therefore seem of even more importance that therapy be prescribed for the tuberculosis as if no psychosis existed.

Table I is a summary of the 11 thoracoplasties. Perusal of this table shows that in every case, the patients were able to pass through the first few postoperative days without difficulty. They were handled almost as easily as the average sanatorium patient. In all but one, the mental condition improved in some if not in every respect. All of the patients were quiet and cooperative. At six months to one year postoperatively eight of the 11 patients had reverted to their preoperative mental state. One (J.H.) was in complete remission and is still doing well, two years postoperatively. A.T. shows slow progressive improvement mentally as well as physically. C.D. is also improving slowly. He has thoracoplasty on the left and pneumothorax on the right side. Five of these 11 patients have been transferred to the psychiatric services as arrested.

We now feel that primary thoracoplasty is preferable to pneumothorax because of the poor results obtained with the latter. Even if the collapse is adequate, the treatment extends over a period of years and the patient's mental condition is unpredictable. Thoracoplasty is more quickly accomplished and permanent.

SUMMARY

1) Diagnostic study of the psychotic tuberculous patient can be done almost as easily as with the non-psychotic patient.

2) All forms of therapy can be given to this group of patients.

3) Major thoracic surgery in the form of thoracoplasty is entirely feasible in the psychotic patient no matter how hyperactive and uncooperative he might be before the operation.

4) In mental patients thoracoplasty, which is quicker and more permanent, is the treatment of choice.

5) Any psychotic patient can be bronchoscoped with ease with transtracheal pontocaine anesthesia and intravenous sodium pentothal.

RESUMEN

1) El estudio diagnóstico en el enfermo psicótico puede hacerse tan facilmente como en el no psicótico.

2) Todas las formas de tratamiento son aplicables a ellos.

3) La toracoplastia puede realizarse en ellos aunque sean muy activos y no cooperen antes de la operación.

4) En los mentales la toracoplastia es de elección por su efecto rápido y permanente.

5) Cualquier psicópata puede soportar la broncoscopía con pantocaína trantraqueal y pentotal sódico intrabenoso.

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Treatment of Tuberculosis with a Low Carbohydrate High Protein Diet*

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In a previous communication[1] the beneficial effect of a low carbohydrate high protein diet on a group of patients with far advanced pulmonary tuberculosis was described. These patients were unsuitable for any form of collapse therapy and their prognosis was poor. They made such good response to this diet that some were discharged as arrested cases while others became suitable risks for surgery. World War II interrupted further studies with the diet. Two recent reports have confirmed the superior value of the low carbohydrate diet over the usual hospital diet.[2,3] Cullen et al.[4] reported closure of large cavities in a group of patients in which a low carbohydrate diet was prescribed and a low pressure chamber was used to immobilize the lungs.

In the original report[1] the rationale for the use of the diet is discussed in detail. Briefly, all foods containing starch and sugar are eliminated because there is evidence that the continued ingestion of such foods depresses total bodily oxygen consumption to levels below basal oxygen needs. Benedict and Carpenter[5] observed a smaller oxygen consumption after starch and sugar than after protein. In some experiments an actual fall in oxygen consumption below basal requirements occurred, a phenomenon they were unable to explain. A study of blood sugar levels following regular hospital meals containing starch and sugar made by the author on 23 patients with pulmonary tuberculosis revealed that five had hyperglycemia (21 per cent); two had hypoglycemia (9 per cent); and 16 had normal blood sugar (70 per cent) (Graphs 1, 2, 3, 4). Kramer[6] did 100 glucose tolerance tests on 100 patients with pulmonary tuberculosis. He found 41 to have abnormal curves: 17 showed the hyperglycemic type and 24 the hypoglycemic type of curve. The rest had normal curves. His higher percentage of abnormal curves may be attributed to the employment of pure glucose solution in the tolerance tests, whereas the blood sugar values in our patients were obtained after ordinary hospital meals.

From available experimental and clinical data it was thought that such a diet could be beneficial in the treatment of tuberculosis because it would increase oxidations in the entire organism

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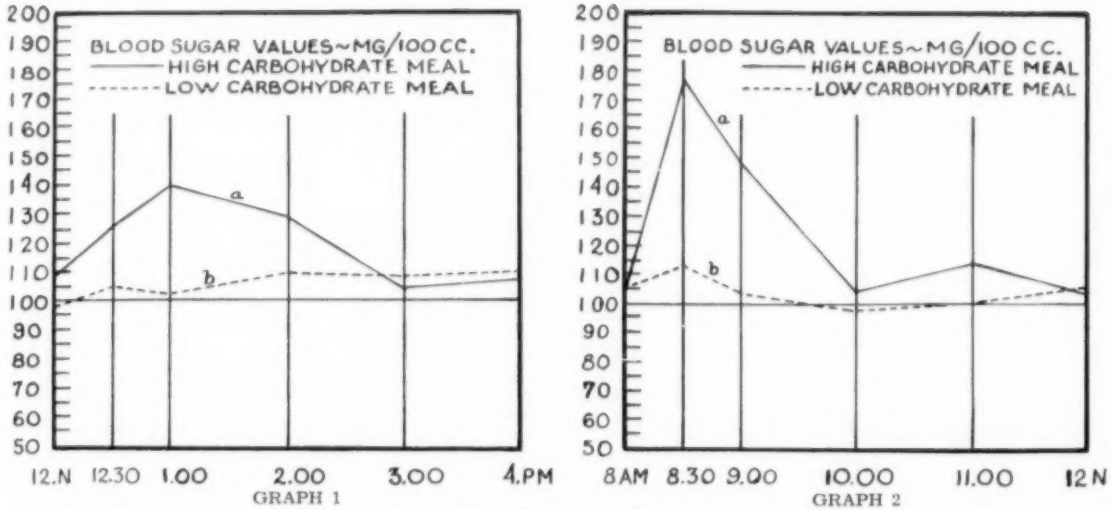
by removing the depressant effect of carbohydrate-rich foods on bodily oxygen consumption. An attempt will be made to show that the continued ingestion of a diet containing carbohydrate-rich foods, like any general hospital diet, may depress glucose-oxygen consumption by producing hypoglycemia in non-diabetics, and by aggravating an already existing disturbance in carbohydrate metabolism in patients with tendency to hyperglycemia. It is also likely that a low carhohydrate diet brings about clinical improvement, maintains normal blood sugar levels, and increases glucose-oxygen consumption by bringing about and maintaining normal liver glycogen storage. Susceptibility to, and persistence of tuberculous infection, are probably fundamentally related to the amount of glycogen stored in the liver. For this reason good nutrition, physical and mental rest have been effective therapeutic measures in the treatment of tuberculosis. Rest is effective because it makes available for healing processes glucose and oxygen which might have been used for muscular energy.

Evidence that a high carbohydrate intake may favor the development of tuberculosis, and that a low carbohydrate diet may protect against tuberculosis, has accumulated from various sources. Faber,[7] in an analysis of factors responsible for the increase in tuberculosis mortality in Denmark, Sweden and England during World War I, concluded that the reduced consumption of meat and fish was the most important nutritional factor. He writes:

"In Denmark the increase in tuberculosis mortality took place in 1916-1917 simultaneously with a greatly reduced consumption of meat and fish, and the decrease of the mortality coincided with a greatly increased consumption of these foods. If we take beef, veal, and fish alone, the fall in consumption was extraordinary in 1915-1916. The total calories consumed was not diminished because there was sufficient bread and flour." He continues, "We see the same thing in Sweden, though to a less marked degree. The rise in tuberculosis mortality was recorded in 1914-1916, and in those years the consumption of bread and flour rose, whereas that of meat decreased. After 1916 we see a steady and continuous fall in tuberculosis mortality, and at the same time flour foods fell off while the consumption of meat and particularly fish rose rapidly. It may be added that in England, too, a rise in tuberculosis mortality coincided with a lower consumption of meat and butter and an increased consumption of flour foods."

Weigert[8] found that guinea pigs fed a carbohydrate-rich diet and then inoculated with tubercle bacilli developed a much severer form of tuberculosis than did guinea pigs fed a carhohydrate-poor diet. Adlersberg and Porges[9] employed a low carbohydrate diet in the treatment of lung abscess, bronchiectasis and other inflam-



Graph 1: Average blood sugar values in six patients who show normal values after high and low carbonhydrate meals. Curve (a) shows course after a regular hospital lunch (high carbohydrate) consisting of ordinary servings of meat, green peas, macaroni, two slices of white bread, one pat butter, salad, one-half pint milk, lemon pie, coffee and cream with two teaspoons of sugar. Curve (b) shows course after a low carbohydrate lunch consisting of ordinary servings of meat, cabbage, beets, salad, two soy bean flour muffins, one pat butter, one-half pint milk, coffee and cream.—*Graph 2:* Average blood sugar values in five patients who show hyperglycemia after a high carbohydrate meal. Curve (a) shows course after a regular hospital (high carbohydrate) breakfast consisting of one-half glass orange juice, bowl of oatmeal sweetened with two teaspoons of sugar, two eggs, two strips of bacon, two slices of toast, one pat butter, coffee and cream with two teaspoons of sugar. Curve (b) shows course after a low carbohydrate breakfast consisting of one-half grape fruit, two eggs, three strips of bacon, two soy flour muffins, one pat butter, one-half pint milk, coffee and cream.

matory states. They attribute clinical improvement to the dehydrating and "antiphlogistic" effects of such a diet.

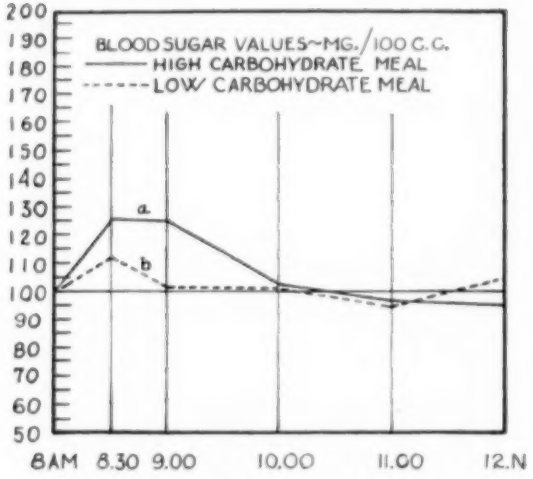
The continued consumption of carbohydrate-rich foods may cause susceptibility to infection because it may depress blood sugar levels, thereby reducing the delivery of glucose to tissues for utilization. This is analagous to the uncontrolled diabetic's susceptibility to infection; in both the end result is a subnormal oxidation of glucose. McCullagh and Johnston[10] have shown how a continued high carbohydrate intake may depress blood sugar levels.

The rationale for a low carbohydrate diet in the treatment of tuberculosis was based on clinical observations and blood sugar studies made on a large group of patients with chronic hypoglycemia and chronic hyperglycemia successfully treated with a low carbohydrate diet. During these studies it was noted that patients on a low carhohydrate diet reported a reduction in the number of respiratory infections. Patients who were having frequent head colds reported fewer, which were milder and shorter in duration. Patients subject to frequent attacks of grippe and bronchitis with persistent cough and sputum did remarkably well on such a diet. It seemed likely that the disturbance in carbohydrate metabolism could be a factor of susceptibility to respiratory infections, acute and chronic. In addition to relief from, and protection against respiratory disorders, these patients improved notably in regard to general health. They appeared more vigorous and buoyant.

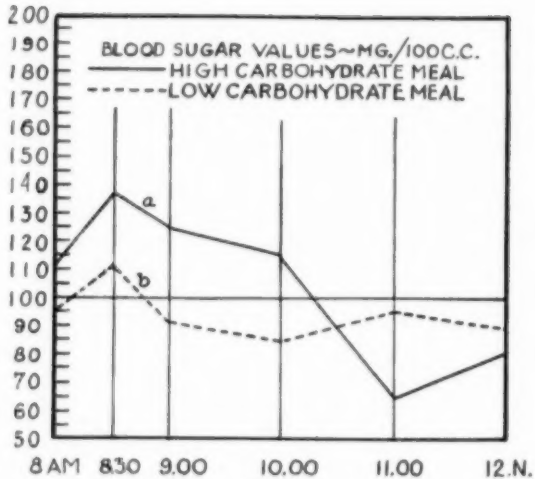
Paton[11] reported a reduction in incidence of cases of catarrhal illness in a large boarding school for girls in England during World War I. He states that the factor responsible was the reduction in carbohydrate intake, especially sugar, during those years. Several houses in a boarding school for girls had different rates of sugar consumption, 1.2 to 2.2 pounds a week per head. The house with the lowest sugar consumption had a catarrhal rate of 5.5 per cent, while that with the highest had a rate of 24.6 per cent.

Spiesman and Arnold[12] found in following a group of chronic head-cold sufferers that a low carbohydrate diet was the most effective means of reducing the incidence of, and susceptibility to, the common cold. Investigations from the Rowett Research Institute[13] have recorded that a study of the diet and health of two East African tribes revealed that the mortality from bronchitis and pneumonia was 10 times as great in one tribe which was cereal eating, as it was in the other which was carnivorous in habit.

Physiological considerations: Patients with these disturbances in carbohydrate metabolism suffer because of a reduced glucose utilization. In hypoglycemia there is insufficient glucose delivered



GRAPH 3



GRAPH 4

Graph 3: Average blood sugar values in ten patients with normoglycemia after high and low carbohydrate breakfasts. Composition of meals similar to those described in graph 2.—*Graph 4:* Average blood sugar values in two patients who show hypoglycemia after a regular high carbohydrate breakfast and normoglycemia after a low carbohydrate breakfast. Note greater stability of blood sugar levels after the low carbohydrate meal. Composition of meals similar to those described in graph 2.

to tissues for utilization. In hyperglycemia (diabetes) the glucose is not being utilized in normal quantity. Since it has been established that tissues utilize oxygen in proportion as they utilize glucose, it is evident that in the presence of reduced glucose utilization there is an actual tissue asphyxia of varying degree depending on the severity of the metabolic disturbance. Dameshek et al.[14] found that during insulin hypoglycemia in man there was a diminished oxygen consumption by the brain. Himwich and Fazekas[15] found that during insulin hypoglycemia in dogs there was a diminished oxygen uptake by the brain. Holmes,[16] Dickens and Greville,[17] and Wortis,[18] using the Barcroft-Warburg technique, found that the oxygen uptake of excised pieces of brain, spinal cord, heart, testis, kidney and spleen fell as the amount of glucose in the nutrient medium was reduced.

In addition to the chronic reduction in glucose-oxygen consumption as a cause of symptoms, patients with these disorders may suffer because of wide fluctuations in blood sugar concentrations with periods of rapid fall to absolute or relative hypoglycemic levels. During such periods of rapid fall, symptoms such as headache, dizziness, faintness, nervousness, tremors, sweating, pallor, flushing, palpitation, tachycardia, abdominal pain and psychoneurotic manifestations may occur. A rapid fall in blood sugar from 200 mg. to 150 mg. in a diabetic will cause symptoms exactly like those occurring in a non-diabetic who experiences a fall from 100 mg. to 50 mg. Headache, dizziness, faintness and psychoneurotic manifestations may be attributed to the effect of the fall in blood sugar on the brain itself. Since the central nervous tissues burn glucose exclusively for energy purposes they are extremely vulnerable to sudden changes in blood sugar levels. Symptoms such as nervousness, tremors, sweating, pallor, palpitation and tachycardia are due to adrenal-sympathetic stimulation occasioned by the fall in blood sugar, a protective mechanism which comes into play at hypoglycemic levels.[19]

A low carbohydrate, high protein diet restores the blood sugar to more normal levels. Clinical improvement may be attributed to an increased glucose-oxygen consumption on such a diet. Further, it is likely that such a diet, paradoxically, actually increases liver glycogen stores to more normal levels in patients where a subnormal storage exists. Since the breakdown of liver glycogen is the ultimate source of the blood sugar, a well-stocked liver is essential to normal carbohydrate metabolism. This holds true for the nondiabetic just as it does for the diabetic. Since glucose is by far the most important source of energy, the need for adequate glycogen stores is obvious. Glucose is needed not only for heat production and muscular activity, but also for protection against

infection. Richardson[20] concluded that "under-fed rabbits with depleted liver glycogen developed definitely lower agglutinative titre after typhoid vaccine than did well fed controls with higher liver glycogen." He also found a "significant correlation to exist in normal rabbits and depancreatized cats between the percentile amount of glycogen in the liver and the survival time after intravenous inoculation with bacteria."[21] Control of the diabetic with diet and insulin brings about an increase in liver glycogen stores and enables him to resist infection. By the same token susceptibility in the nondiabetic may result from inadequate liver glycogen stores with resultant subnormal glucose-oxygen consumption.

Because of the clinical improvement noted in our patients on the low carbohydrate diet, there is a strong possibility that there was a concomitant increase in liver glycogen stores. It is well known that improvement in diabetes is associated with an increase in liver glycogen stores on restricted carbohydrate diets, with or without insulin. It is likely that improvement in patients with hypoglycemia may also be accompanied by increase in glycogen stores, even on a low carbohydrate intake. There is experimental evidence that a so-called balanced diet with fairly high intake of carbohydrate-rich foods need not bring about normal liver glycogen storage, but, in fact, may produce a fatty liver. Spellberg and Keeton[22] produced liver changes in guinea pigs and rabbits with diets containing an abundance of carbohydrates in the form of oats, wheat bran and dextrose. They state, "The development of liver changes in an animal receiving an 'adequate' diet leaves one to wonder whether our conception of such a diet is not an erroneous one." It has been our impression for some time that the continued ingestion of carbohydrate foods may prevent normal liver glycogen storage. From clinical observations we have concluded that a diet rich in protein and low in carbohydrate-rich foods can better bring about normal glycogen stores, especially in the presence of infection.

In the case of the patient with hypoglycemia the reduced glucose delivery to tissues results in a reduced glucose-oxygen consumption. This resultant tissue asphyxia may lower the resistance of the organism to bacterial invasion. A chronic hypoglycemia may thus favor the development of a disease such as tuberculosis. Variation in the degree of the metabolic disturbance will influence the severity and course of the infection. An acute disturbance in carbohydrate metabolism, such as would accompany a short period of hypoglycemia, may be responsible for the onset of an acute infection such as poliomyelitis. Sandler[23] was able to produce necrotic lesions in the anterior horn cells of rabbits with the virus of poliomyelitis by inoculating rabbits during insulin hypo-

glycemia. The rabbit is ordinarily resistant to the virus. This resistance has been attributed to the fact that its blood sugar never falls below 100 mg. per 100 cc.

The present study is based on observations made during the period June 1946 to June 1947 on a group of 38 patients, 20 of whom had far advanced disease, 16 moderately advanced disease, one minimal disease, and one the primary type of disease. Only six of these patients had a poor prognosis. Of the 38 patients, 37 had been in the hospital for from three to 16 months and were eating the regular hospital diet before they were given the low carbohydrate diet. The time spent on the regular diet served as a control period for the comparative study of the clinical and roentgenological changes which occurred on the special diet. Only one patient was given the special diet on the day of admission. He was acutely ill and the diet was prescribed immediately.

Pneumothorax was done in 17 of the 38 patients taking the diet; in three it was bilateral. In 15 of these 17, pneumothorax had been induced before the diet, and in two after the diet was prescribed. It is significant that pneumothorax patients with no visible cavity on roentgenogram and with negative sputum showed considerable clinical improvement shortly after taking the diet.

Results: Of the 38 patients, 35 reported significant improvement as measured by cough, amount and character of sputum, weight, bodily strength, dyspnea, fatigue, appetite, gastrointestinal symptoms, mental alertness, morale, nervousness, headache, chest pain, and a few miscellaneous symptoms. Seventeen of the 38 patients showed improvement of the pulmonary condition on serial roentgenograms. The remaining 18 showed static lesions. In most of these pneumothorax had been induced and it was difficult to detect clearing of lesions in a collapsed lung. Three patients who had completed thoracoplasty many months before and who were making little or no progress clinically prior to the regimen, responded favorably to the change in diet.

Cough and Sputum: Thirty of the 35 patients showed significant decrease in cough. Five patients who had minimal cough reported no change with the diet. Usually after two to three weeks, sometimes sooner, patients reported less cough. Paroxysms of coughing no longer occurred. A few patients who had gagging or vomiting with severe cough, especially in the morning, became free from such symptoms. With the reduced cough the sputum gradually became less in amount, thinner, frothier, and was more easily expectorated. This impressive reduction in cough was soon reflected in reduced consumption of narcotics and cough mixtures. During the entire year of investigation routine daily medication was not prescribed for a single patient.

Weight: The sudden withdrawal of starch and sugar may result in loss of tissue water since these foods tend to cause tissue hydration. Hence, some patients show an early loss in weight which may persist for several weeks. Overweight patients usually lose, and underweight patients usually gain. However, some underweight patients may lose considerable before they gain and show concern over the loss. It is necessary to warn patients that the diet may cause a weight loss in spite of adequate caloric intake. Usually the patient's concern over loss in weight is offset by the early clinical improvement. Of the 35 improved patients, two showed no change in weight, 19 gained in weight, the gain ranging from five to 33 pounds, and 14 lost weight, the loss ranging from five to 14 pounds. Of the 19 patients who showed net gains, six gained without initial loss, and 13 had initial loss during the first weeks followed by a sustained gain above the weight noted at the start of the diet.

Bodily Strength: An increase in bodily strength was the most striking and consistent subjective symptom of improvement and was reported by nearly every patient, and was sustained throughout the period of observation. Patients reported that they felt "stronger in their arms, body, and legs." They could turn in bed without discomfort. They wanted to sit up more often and to get out of bed and "do things." Before the diet, all of the patients who had bathroom privileges felt tired and dyspneic after returning from the toilet or after taking a shower. After two to three weeks they lost these symptoms and said they felt "practically normal." Patients also noted freedom from palpitation and rapid pulse. This return of bodily vigor appeared long before there were appreciable roentgenographic changes. Some patients stated that they felt even better than when they were in supposedly good health. Two patients noted weakness at times during the first weeks on the diet but gained strength eventually.

Appetite: Of the 35 improved patients, 26 reported increased appetite. The remaining nine said they always had a good appetite and saw no change with the diet. Improvement was often striking and was manifest during the first week. Some patients who had no appetite and who were actually nauseated by the sight and smell of food were able to enjoy meals for the first time since the onset of their illness. Often patients complained of constant hunger during the early weeks of the diet. It is therefore advisable to give between-meal feedings of milk, milk and cream, tomato juice, or cheese.

Gastrointestinal Symptoms: Ten patients had annoying gastrointestinal symptoms on the regular hospital diet, such as gas, sour eructations, belching, vague abdominal discomfort or pain,

constipation, and recurrent diarrhea. One vomited shortly after meals at irregular intervals ever since he had taken sick. With the new diet vomiting ceased during the first week and did not recur during the 12 months he was on it. Another patient required sedation for nausea before and after meals. After taking the diet one week these symptoms disappeared and did not recur. A third who had nausea before every meal was free of this symptom after two weeks. Two who had recurrent attacks of abdominal pain were relieved by the diet after one to two weeks. Two who had chronic constipation reported regular bowel function after two to three weeks. One of them had been constipated since childhood. One who had recurrent attacks of diarrhea while taking the regular diet was entirely free on the special diet.

Morale: Thirteen patients reported a significant change in morale after they went on the diet. This change in psyche was often striking. Moroseness, morbid introspection, gradually were replaced by hope and buoyancy. Chaplains and Red Cross workers who made the rounds on various wards commented on the hopeful air, buoyancy, and cheerfulness of the special diet patients as compared with those on the regular diet wards. These workers were not aware of the difference in diet and their observations were spontaneous, unbiased, and genuine.

After a few weeks patients became mentally alert, more interested in their environment and neighbours. Instead of wanting to sleep most of the time they busied themselves with talking, reading, and occupational therapy. Some patients were able to read for only short periods of time because their eyes tired easily and they would doze off to sleep. Under the regimen they were able to read for long periods and without eye fatigue.

Nervousness: Four patients complained of irritability, tremors, especially when receiving pneumothorax refills, restlessness, and vague abdominal "quivering." Irritability often resulted in fits of anger and clashes with nurses or attendants. These patients required frequent sedation, some daily. They all reported practically complete relief from these symptoms after several weeks of the regimen.

Headache: Two patients had frequent and often severe headaches. Both reported freedom on the diet.

Chest pain: Some patients had sharp and fleeting chest pains or dull ache not associated with pleurisy or pleural effusions or the site of the lesion. These symptoms abated.

Sputum Studies: No attempt will be made to draw any conclusions regarding the effect of the diet on the incidence of tubercle bacilli in the sputum or gastric contents since the patients did not continue under observation until treatment was completed.

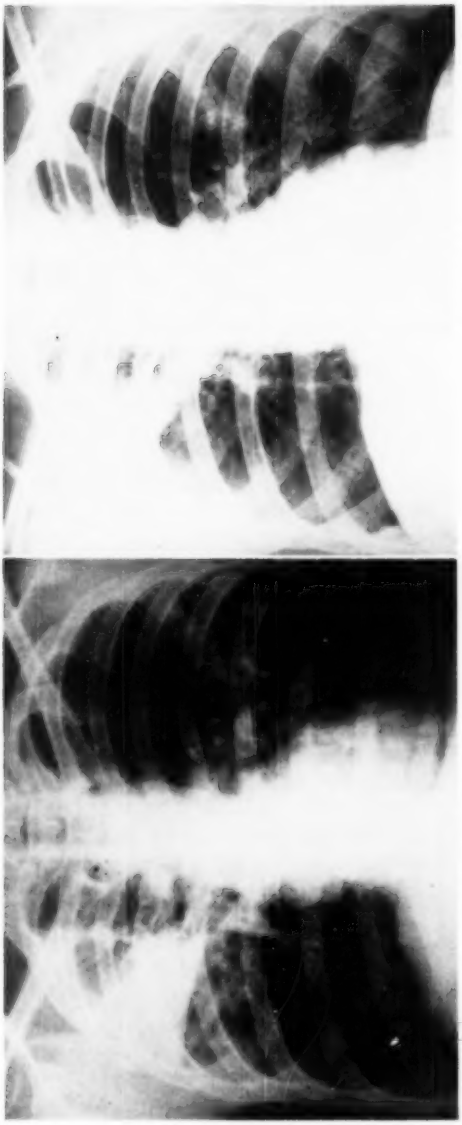


FIGURE 2

FIGURE 1

Also, most of the patients receiving pneumothorax showed negative sputa before the diet was prescribed. Of the 38 patients, seven showed negative sputa on bed rest and after the diet was prescribed.

CASE REPORTS

Case 1: H.B., a 19-year-old white male, was admitted on January 8, 1946 with far advanced pulmonary tuberculosis following a pulmonary infection which began in November, 1945. The sputum was positive for M. tuberculosis. He had lost 30 pounds in the two months before admission. Routine examination of the chest on January 31, 1946 showed a dense uniform consolidation of the lateral portion of the right upper lobe with a 4 cm. cavity. There were soft, coarse, parenchymal lesions extending from the right hilum, and evidence of a bronchogenic spill into the left mid-lung field (Fig. 1). Thoracoplasty was refused by the patient. On March 21, 1946 roentgenograms revealed the right upper lobe lesion to be denser, and the lobe showed contraction. The cavity was smaller and less distinct. The special diet was prescribed on July 1, 1946. At this time he had occasional temperature elevations to 100 degrees F., moderate cough productive of about one ounce of thick dark green sputum in 24 hours. He felt weak and tired easily; weighed 195 pounds. Within a few weeks cough was less, and the sputum was whiter, thinner, and smaller in amount. Roentgenogram on July 30, 1946 showed a 2 cm. cavity in the right upper lobe (Fig. 2). Roentgenogram on October 11, 1946 showed some clearing in the left mid-lung field and some clearing with further contraction in the right upper lobe. The sputum was positive on culture on November 21, 1946. Following this date, all sputa were negative both by concentrate and culture. Roentgenograms on January 8, March 6 and May 1, 1947 showed progressive clearing with further contraction and fibrosis of the right upper lobe. No cavities were visible on lordotic views (Fig. 3). The sedimentation rate on May 23, 1947 was 7 mm. in one hour. His weight on June 1, 1947 was 205 pounds. He left the hospital June 15, 1947 and has been taking the diet. Roentgenogram on October 28, 1947 showed a clear left lung and fibrosis of the right upper lobe (Fig. 4). There is practically no change since the film taken on May 1, 1947. His weight on November 7, 1947 was 219 pounds. He has no symptom.

Comment: This patient became so enthusiastic about the diet that he has been virtually carnivorous since January, 1947. While he showed roentgenographic improvement before the diet was prescribed, the acceleration in recovery, especially clinically, was very obvious afterward.

Case 2: L.A.W., a white male, 30 years old, was admitted on October 3, 1945 because of findings on a routine roentgenogram of the chest at the time of separation from military service on August 27, 1945. He had no pulmonary symptom. A roentgenogram of the chest taken on October 6, 1945 revealed scattered exudative lesions with multiple areas of cavitation in the right upper lobe and similar, though less extensive lesions in the lower part of the left upper lobe (Fig. 5). Right pneumothorax was induced on October 12, 1945 and a right pneumonolysis was done on December 7, 1945. In January 1946 he complained of right chest pain,

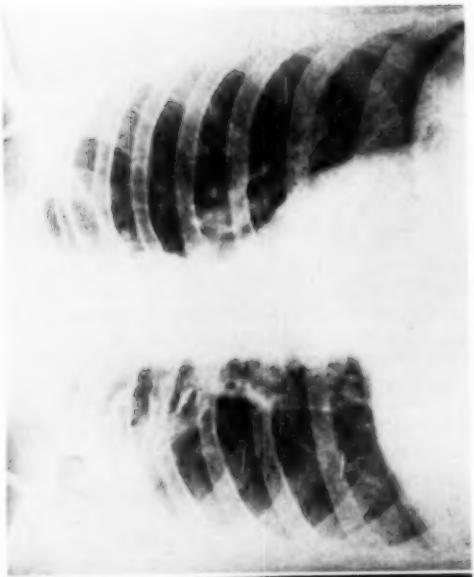


FIGURE 4

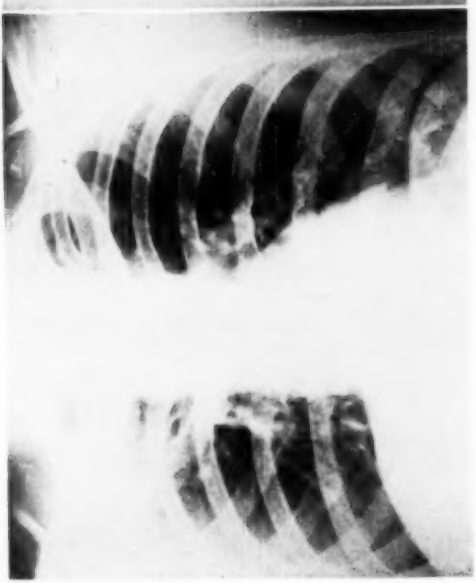


FIGURE 3

night sweats, dyspnea, and malaise. Roentgenogram on January 28, 1946 showed extensive multiloculated pleural effusion. On aspiration, fluid was thin, yellow, slightly turbid, and positive for M. tuberculosis. Frequent aspirations were necessary yielding from 200 to 1500 cc. at a time. The fluid became thicker, dark brown in color, and increasingly opaque. By June 1946 there was a frank empyema positive on smear for M. tuberculosis. Large yellow fibrinous flakes were present in the fluid. His general condition at this time was poor. He was weak, tired easily, and was depressed and morose. He had frequent attacks of epigastric pain before breakfast, moderate cough and thick green sputum. He was afebrile. The sedimentation rate was 21 mm. in one hour. A roentgenogram of the chest taken on June 26, 1946 revealed considerable collapse of the right lung, marked visceral pleural thickening, and the presence of fluid (Fig. 6).

The special diet was prescribed on July 1, 1946. After a few weeks his appetite improved, he felt stronger, more alert, less depressed, and was

FIGURE 5

FIGURE 6

FIGURE 7

FIGURE 8

free of epigastric pain. The chest fluid on August 30, 1946 was light yellow, thinner, slightly turbid, and free of fibrin flakes. Aspirations were performed at longer intervals during the latter half of 1946 and yielded not more than 300 cc. at a time. The fluid became progressively thinner and less turbid, although it was still positive on culture. A roentgenogram of the chest on December 20, 1946 showed some re-expansion of the right lung and a clear left lung. The right half of the thoracic cage was smaller than the left half due to shrinkage of the right pleural contents. A roentgenogram on February 19, 1947 showed almost complete re-expansion and a small amount of fluid (Fig. 7). The sedimentation rate was 10 mm. in one hour on May 19, 1947. On June 16, 1947 he weighed 164 pounds, having gained 17 pounds. On May 7, 1947 the sputum was negative on smear. He was discharged on June 25, 1947 and returned home. In a personal communication dated November 15, 1947 he stated that he weighed 170 pounds, felt normal, had negative sputum, and was still taking the diet. A roentgenogram on December 15, 1947 shows complete re-expansion of the right lung, no evidence of cavity, and no fluid (Fig. 8). A roentgenogram of the chest made in June 1949 showed no change. He informed me that he is asymptomatic and that his sputum is negative.

Comment: This case of frank tuberculous empyema made a remarkably rapid recovery with the diet. Until the diet was prescribed his course was steadily downhill, and it appeared that thoracoplasty was required. Following the diet, there was a rapid and sustained turn for the better, both clinically and roentgenologically. During the five months from January 30 to June 30, 1946, before the diet, he had 14 chest aspirations yielding a total of 6,350 cc. of fluid, with no improvement in the empyema. During the five months regimen, July 1 to December 1, 1946, he had seven chest aspirations yielding a total of 1,300 cc. and with marked improvement in the empyema. This is the second case of empyema successfully treated with diet and aspiration. The first case was described in the original article.[1]

Case 3: J.P., a white male, 22 years old, was admitted on February 25, 1945 because of cough, dyspnea on exertion, and night sweats. The sputum was positive for M. tuberculosis. A roentgenogram of the chest revealed extensive scattered discrete lesions in the left upper lobe with a 3.5 cm. cavity. There were similar lesions in the right upper lobe. Left pneumothorax was induced on March 23, 1945. Pneumonolysis was attempted on July 23, 1945 but was not feasible. The lung was allowed to re-expand. Between December 3, 1945 and February 4, 1946 thoracoplasty in three stages was completed with successful collapse of the left upper lobe. After March 26, 1946 the sputum was negative, on concentration and culture. Following the operation a chest wall abscess appeared in the left precordial area extending to the midline of the sternum. It was incised on April 9, 1946. Following the incision two sinuses drained profuse, purulent material positive on culture for M. tuberculosis. The diet was prescribed on July 1, 1946. At that time the sputum was negative. A roentgenogram showed a clear right lung and a left thoracoplasty. The skin of the precordium was edematous and tender and undermined.

The patient was bed-ridden, weak, dyspneic, and had considerable cough during the day and night. The sputum was moderate in amount, thick dark gray in color. He had considerable pain in the left shoulder. He weighed 113 pounds and had lost 25 pounds since admission to the hospital. He had temperature elevations up to 100 degrees F. Following the diet there was a gradual and sustained improvement in all respects. His appetite improved, and the morning nausea and vomiting ceased. He became stronger and got out of bed more often. The chest wall sinuses began to drain less profusely. One sinus closed at the end of two months, the other at the end of three months. There was a noticeable change in the texture of his hair after several weeks. Roentgenograms in December 1946 revealed no change from the film taken shortly after completion of the thoracoplasty in February 1946. He left the hospital on December 30, 1946. At this time he weighed 129 pounds, having gained 16 pounds in the six months while taking the diet. The change in appearance, behaviour, and mental outlook in this patient was truly striking.

Case 4: L.S., a white male, 23 years old, was admitted on August 14, 1945. The sputum was positive for M. tuberculosis on smear. A roentgenogram taken on August 15, 1945 showed soft infiltrations in the left upper lobe. On September 27, 1945 there was evidence of cavitation in the left upper lobe, and on October 25, 1945 the disease had spread to the upper part of the left lower lobe. Pneumothorax was unsuccessful because of adhesions. A two-stage thoracoplasty with removal of the first six ribs was completed on November 30, 1945. All during 1946 the patient had positive sputum and made no clinical improvement. The diet was prescribed on December 26, 1946. At the time he had moderate cough productive of thick yellow sputum. His appetite was fair. He tired easily after going to the toilet and had to take bed baths. A few weeks after the diet was instituted there was less cough, the amount of sputum was decreased and became thinner and whiter. After seven months on the diet he had gained 21 pounds, and only occasionally positive sputa were obtained. He was transferred to another hospital on June 16, 1947 from which he was shortly discharged as having received maximum hospital benefit.

Comment: This patient had a stationary course both clinically and roentgenologically for a year after completed surgery. Active disease was still present in the left lung. After the diet was prescribed there was a definite and sustained recovery. After seven months he had gained 21 pounds, was virtually symptom free, and stated that he felt practically normal in all respects.

Case 5: L.E.R., a white male, 27 years old, was admitted on November 30, 1945. The sputum was positive for M. tuberculosis on smear. A roentgenogram on November 17, 1945 showed a 2.5 cm. cavity in the left upper lobe, pleural thickening and fibrosis, and parenchymal lesions in the right third interspace. Left pneumothorax was induced on December 17, 1945. The sputum was positive on smear on April 15, 1946. On July 1, 1946 the special diet was prescribed. At that time he was still a bed patient, had cough productive of a moderate amount of thick dark sputum. He tired easily and required frequent sedation. A roentgenogram on June 5, 1946 revealed adequate collapse of the left lung and a

clear right lung. After taking the diet four weeks there was noticeable improvement. His cough became minimal. The sputum was thin, white, and was expectorated with greater ease. His appetite was good and he felt stronger. In November he went home on a 12-day leave. A roentgenogram taken on November 25, 1946 showed almost complete re-expansion of the left lung with no evidence of cavity. In view of his excellent general condition and negative sputum the lung was allowed to re-expand completely. On January 23, 1947 a roentgenogram of the chest, including lordotic views, revealed a completely re-expanded left lung with no evidence of cavitation. On February 10, 1947 no change was observed. He was discharged as an arrested case on February 20, 1947. Within a few weeks he felt well enough to return to work in an electric appliance factory. In a personal communication in August 1948 he stated that he is well and still at work.

Comment: This patient's pneumothorax was successful; there was adequate collapse and the sputum was negative. Yet clinically there was much to be desired. He was weak and sick. With the change in diet there was prompt acceleration toward recovery and it was possible to discontinue his pneumothorax after about a year.

Case 6: S.C., a white male, 31 years old, had had a productive cough of five months duration. He was admitted on November 9, 1945. The sputum was positive on smear. A roentgenogram on November 20, 1945 revealed soft parenchymal lesions occupying the upper two-thirds of the left upper lobe. In this area were multiple small areas of cavitation, the largest measuring 1 cm. Left pneumothorax was induced on November 22, 1945. The sputum soon became negative on smear and culture. Pneumothorax was adequately maintained on weekly refills. He was in bed most of the time, got along well, and improved slowly. On July 1, 1946 the special diet was prescribed. At this time he had moderate cough. The sputum was thick, grayish black, and measured about one inch in the sputum cup in 24 hours. His appetite was satisfactory. He tired easily. After four weeks on the diet he became more alert mentally, and showed a desire to indulge in some hobby. His cough became minimal. The sputum decreased in amount and became thin and white. His appetite improved. A roentgenogram on August 16, 1946 showed some clearing in the collapsed left lung. On August 26, 1946 he felt well enough to go home on seven days leave. Improvement continued steady. A roentgenogram taken on September 10, 1946 showed almost complete re-expansion of the left lung with no evidence of cavitation. In view of his clinical and roentgenological improvement pneumothorax was kept up with intent of complete re-expansion at an early date. He was discharged from the Navy on December 20, 1946 and left the hospital for home where he continued taking the diet. He returned as an out-patient at regular intervals. A roentgenogram taken on March 24, 1947, including apical views, showed no evidence of cavitation, and a small amount of pneumothorax. The sputum continued negative.

Comment: It was felt that pneumothorax could be safely discontinued in this patient because of the marked improvement clinically and roentgenologically. Close examination of the lung

before re-expansion revealed no evidence of active disease, and warranted discontinuance of the pneumothorax. This patient was overweight (205 pounds, height 5 ft. $10\frac{1}{2}$ inches) when put on the diet. After 11 weeks he weighed 188 pounds and his weight became stabilized at this level.

Case 7: J.E.P., was a white male, 18 years old. Roentgenogram on May 20, 1946 at time of admission revealed a small amount of infiltration above the left second rib anteriorly. He had moderate cough productive of half a cup of thick yellow sputum in 24 hours. He complained of pain in the left chest. The sedimentation rate was 18 mm. in one hour. The sputum was positive for M. tuberculosis on culture. On July 10, 1946 a roentgenogram revealed a spread of his disease. There was now a predominately exudative infiltration above the left second rib with a 1 cm. cavity in the first interspace. On September 4, 1946 a roentgenogram revealed further spread in the left lung with increase in infiltration in the left first interspace and scattered nodular infiltrations throughout most of the left lung. There was also a spread to the right lung with a moderate amount of infiltration appearing in the base of the right upper lobe and accentuation of the minor interlobar fissure. The sedimentation rate was 24 mm. in one hour. The special diet was prescribed on September 9, 1946. After four weeks the cough became minimal. The sputum was reduced one-half ,was thinner and whiter. He was free of chest pain. A roentgenogram taken on December 29, 1946 showed an increase in the amount of infiltration in both lungs. Another on February 19, 1947 showed partial clearing of infiltrations in both lungs. On February 16, 1947 he weighed 172 pounds, having gained 13 pounds in five months. Subsequent serial roentgenograms revealed further clearing in both lungs. On June 16, 1947, at the time of transfer to another hospital, he was symptom free and weighed 185 pounds, having gained 26 pounds on the diet.

Comment: Up until the time the diet was prescribed his course was steadily downhill with spread of the disease in both lungs. I believe the diet definitely checked the spread, reversed the trend of the disease, and helped in clearing of the infiltrations. The clinical change in the patient was striking.

Case 8: T.F., a white male, 21 years old, was admitted on March 12, 1946. A roentgenogram taken on March 14, 1946 showed evidence of soft infiltrations in the right first and second interspaces laterally with a 2 cm. cavity in the second interspace. A roentgenogram made on April 11, 1946 showed a spread of the infiltration in the right second interspace medially. The sputum and gastric contents were negative on culture for M. tuberculosis all during his stay in the hospital. At the time of admission he had a cough productive of a moderate amount of mucopurulent sputum. His appetite was fair. He felt tired after exertion. A roentgenogram on June 17, 1946 showed the cavity to be smaller but there was no change in the extent of the infiltration. The special diet was prescribed on July 1, 1946. After a few weeks the cough was minimal and the sputum became thinner and white. His appetite improved. He no longer complained of fatigue. A roentgenogram on August 15, 1946

showed considerable resorption of infiltrations in both interspaces. No evidence of cavity was seen. Clinical improvement continued. Roentgenograms on December 12, 1946, February 17 and April 18, 1947 showed evidence of a small amount of fibrosis in the right second interspace laterally and a clear first interspace. By April 18, 1947 he was up and about and symptom free. When he began the diet he weighed 165 pounds. After $3\frac{1}{2}$ months he weighed 157 pounds. From then on he regained slowly, so that by April 20, 1947 he weighed 165 pounds. He was discharged on May 20, 1946 as an arrested case, 14 months after admission to the sick list.

Comment: While on the regular hospital diet this patient showed no roentgenographic evidence of improvement and, in fact, had a slight spread. After taking the diet six weeks, there was definite improvement subjectively and objectively along with clearing of lesions on roentgenograms.

Case 9: H.C.D., a white male, 22 years old, had lost 30 pounds in the 19 months before admission. He was admitted on October 5, 1945. The sputum was positive for M. tuberculosis on smear. The sedimentation rate was 20 mm. in one hour. A roentgenogram taken on October 6, 1945 showed extensive disease throughout the right lung with several cavities, the largest measuring 4 cm. There was a small lesion with a 1 cm. cavity overlying the left second rib. Right pneumothorax was induced on October 13, 1945. Right pneumonolysis was done on November 19, 1945. Subsequent roentgenograms revealed adequate collapse of the right lung with no visible cavity. The disease in the left lung improved and the small cavity closed. The sputum turned negative on smear and culture in July 1946 and remained so thereafter. In spite of adequate pneumothorax and negative sputum he was not clinically well. He had considerable cough productive of thick green sputum. His appetite was poor. He was nervous and irritable, pale and thin. He vomited entire meals at irregular and frequent intervals. These vomiting episodes began in 1945 when he first took ill, and he continued to vomit all during the time he was on the regular diet. He tired readily on ordinary exertion.

The special diet was prescribed on November 20, 1946. In a few weeks there was definite improvement. The cough became less. The sputum was smaller in amount, became thinner and pale yellow. His appetite improved. He had a better color. He last vomited during the first week on the diet. Improvement continued in all respects until he was transferred in June 1947. He had gained only four pounds during the eight months on the diet.

Case 10: T.E.L., a white male, 22 years old, was admitted on September 22, 1945. The sputum was positive for M. tuberculosis on smear. The sedimentation rate was 18 mm. in one hour. A roentgenogram revealed evidence of fibroulcerative disease in both upper lobes with a 4 cm. cavity in the right and a 2.5 cm. cavity in the left. Left pneumothorax was induced on October 11, 1945 followed by pneumonolysis on October 25, 1945. Right pneumothorax was induced on October 31, 1945 followed by pneumonolysis on November 20, 1945. Subsequent roentgenograms revealed adequate bilateral collapse. The sputum was positive until October 3, 1946 and remained negative thereafter. On September 13, 1946 the

special diet was prescribed. At this time he had considerable cough productive of one-third of a cup of muco-purulent sputum. He had frequent pains over both sides of the chest. He felt weak. He was tired and dyspneic after going to the toilet, after showers, and after standing up to wash. He was nervous and apprehensive whenever he got refills. His appetite was good. He belched frequently and was constipated. After four weeks on the diet there was less cough. The sputum was less, thinner and white. He was not so tired or nervous. His bowels became regular and he quit belching. Improvement continued steadily. At the end of three months he was practically symptom free. Roentgenograms made during 1947 showed no changes. The sedimentation rate fell to 9 mm. in one hour on May 19, 1947. His weight was stationary throughout.

Comment: This patient was making apparent progress on the regular hospital diet, yet he showed an accelerated and sustained improvement clinically after the special diet was prescribed.

Case 11: B.R.C., a white male, 22 years old, was admitted on February 22, 1946. The sputum was positive for M. tuberculosis on smear. A roentgenogram taken on March 12, 1946 showed evidence of nodular infiltrations occupying the entire right lung with a 7 cm. cavity in the right apex. There was a similar nodular infiltration in the left lung above the third rib with a 4.5 cm. cavity in the apex. This film represented a spread compared with a film taken on February 18, 1946. Roentgenograms taken on April 11 and June 17, 1946 showed slight increase in the extent of the infiltrations and in the size of both cavities. Because of the grave prognosis he was not given collapse therapy. On July 1, 1946 the special diet was prescribed. At this time he coughed frequently during the day and sometimes at night. The sputum was black, thick, and filled about two-thirds of a cup in 24 hours. His appetite was poor. He felt sick all the time, did not feel like getting up, and preferred bed baths. His morale was poor. He tired easily. After a few weeks on the diet he stopped coughing at night, and coughed less during the day. The sputum became thinner, pale green, and was brought up more easily. He felt stronger and preferred showers to bed baths. His morale improved. A roentgenogram taken on August 14, 1946 showed a slight increase in the size of the cavities. On October 15, and December 17, 1946 there was evidence of slight clearing in both lungs but with no change in the size of the cavities. Because of his good clinical state and static condition of the cavities, left pneumothorax was induced on December 20, 1946 with about 50 per cent collapse of the left upper lobe and moderate decrease in the size of the cavity. Partial pneumonolysis was done on January 22, 1947. There was no pleural reaction. Right pneumothorax was induced on April 16, 1947. Bilateral refills were kept up until his transfer to another hospital on June 16, 1947. At this hospital his condition was satisfactory for thoracoplasty which he weathered without complication.

Case 12: J.M.P., a white male, 33 years old, was admitted on August 28, 1945. The sputum was positive for M. tuberculosis on culture. A roentgenogram on August 28, 1945 revealed scattered areas of infiltration in both apical regions, with a small cavity in the left first interspace. He was put on bed rest. Roentgenograms on October 2, 1945, January 8 and February 25, 1946 showed no changes. On April 23, 1946 there was evidence of spread of the disease and on June 10 there was

increase of disease in the left mid-lung field. The condition remained unchanged in August and October 1946. Further increase appeared in the left second interspace on December 10, 1946. The special diet was prescribed on December 26, 1946. His general condition at this time was satisfactory. He had minimal cough and sputum. His morale was low and he was depressed because of failure to improve after 18 months of hospitalization. After a few weeks on the diet he felt stronger and more buoyant. A roentgenogram taken on February 17, 1947 showed clearing in the right first and left second interspaces. This was the first time in 20 months that roentgenographic evidence of improvement was reported. He continued to improve until his transfer on June 16, 1947.

Cases With Minor Spreads

Three of the 38 patients had minor increase of disease while on the special diet as follows:

Case 1: J.A.A., a white male, 22 years old, was admitted on March 21, 1946. The sputum was positive for M. tuberculosis on culture. A roentgenogram taken on March 27, 1946 showed soft scattered infiltrations above the right fourth rib surrounding a 2 cm. cavity, and several patches of infiltration above the left third rib. No collapse therapy was given. After May 23, 1946 the sputum was negative and remained so. A roentgenogram on May 28, 1946 showed no change. On July 1, 1946 the special diet was prescribed. After this he improved clinically. No change on roentgenographic inspection was noted until December 18, 1946 when clearing of infiltrations in both upper lung fields was reported, along with almost complete disappearance of the cavity in the right lung. At this time a round lobulated mass appeared in the superior mediastinum on the right side. Serial roentgenograms revealed further clearing along with gradual increase in the mediastinal mass which eventually receded during the summer of 1947. It apparently was an enlarged lymph node.

Comment: This is an unusual spread. The parenchymal lesions cleared, only to be followed by the mediastinal lymphadenopathy which persisted for about a year. The patient was virtually asymptomatic during the presence of the mass.

Case 2: W.F., a white male, 32 years old, was admitted on June 22, 1946. He had lost 25 pounds in the six months before admission and was acutely ill. The sputum was positive for M. tuberculosis on smear. A roentgenogram on July 30, 1946 revealed extensive confluent infiltrations above the right fourth rib enclosing numerous large cavities. There was a bronchogenic spread to the left second and third interspaces enclosing several cavities. There were infiltrations in the left first interspace. On July 18, 1946 the special diet was prescribed. He coughed a great deal. The thick, dark yellow sputum filled about half a cup in 24 hours. He had considerable pain over the left side of his chest. After several weeks on the diet the cough became less and the sputum was thinner, white, and reduced in amount. Roentgenograms on September 3, October 4 and November 4, 1946 showed no change. On December 6, 1946 there was evidence of moderate spread of disease into the base of the right lung. Pneumoperitoneum was induced on December 20, 1946. In January 1947, his general condition became worse. He had a septic temperature and

more severe cough. He had much pain and discomfort following refills and it was necessary to discontinue the pneumoperitoneum. He made favorable clinical response to streptomycin therapy.

Comment: On admission this patient was acutely ill. He was the sickest of all the patients who were given the diet. For a time the diet did reduce his cough and amount of sputum and he was more comfortable. However, there was a moderate spread and he became septic. He responded to treatment with streptomycin. Apparently the disease was too far advanced for any kind of conservative therapy.

Case 3: C.C.W., a white male, 36 years old, was admitted on January 25, 1946. The sputum was positive for M. tuberculosis on culture. A roentgenogram revealed evidence of soft infiltrations in the left upper lobe above the third rib with a 3 cm. cavity. After a few months on bed rest the cavity was still present and left pneumothorax was induced. Roentgenograms showed adequate collapse with cavity closure. His clinical course was stationary except for a loss of 15 pounds since induction of pneumothorax. On December 26, 1946 the special diet was prescribed. He had slight cough and sputum at this time. After a few weeks the sputum became thinner and white. He also felt stronger. In April 1947, following a severe upper respiratory infection, a roentgenogram revealed a small new lesion in the rignt apex. He was transferred to another hospital on June 16, 1947.

Comment: This patient lost considerable weight because of poor appetite which followed induction of pneumothorax while on the regular hospital diet. It is likely that the resultant poor nutritive state and the occurrence of a severe upper respiratory infection contributed greatly to the development of the spread.

The Diet

The diet employed in this study ranged from 2300 to 2900 calories (carbohydrate, 114 to 124 g.; protein, 100 to 130 g.; fat, 160 to 212 g.). This was divided into three regular meals with feedings between meals (10 a. m. and 3 p. m.) and at bedtime of a glass of milk, or milk and cream mixture, or tomato juice, or cheese. One slice of bread was allowed with each meal. Except for the bread, the carbohydrate content of the diet was ingested in the form of 5 and 10 per cent fruits and vegetables and dairy products. The following carbohydrate-rich foods were completely avoided: cereals, potatoes, corn, rice, sugar, tapioca, split peas, dried beans, noodles, macaroni, spaghetti, cake, candy, ice-cream, pancakes, etc. Soy bean flour muffins were substituted for bread when the former was available. Breakfast would consist of fruit or tomato juice, eggs, bacon or ham or fish, one slice of bread and butter, milk, coffee with cream and without sugar. Lunch consisted of soup or broth, meat or fish or poultry, vegetables, salad,

milk, coffee, one slice of bread and butter. Supper consisted of soup or broth, meat or fish or poultry, vegetables, salad, milk, coffee, one slice bread and butter. Except for the bread, there was no limitation in the amount of permitted foods. Patients were encouraged to eat nuts between meals if they were hungry. High carbohydrate nuts, such as peanuts, cashews, filberts, chestnuts, were not allowed.

During the first weeks on the diet most patients complained of hunger between meals. They did not have the feeling of satiety that comes with eating foods like potatoes, cereals, several slices of bread, etc. For this reason it was necessary to give them feedings between meals and at bed time. After a while, this hunger disappeared and the extra feedings were omitted. Compared with the regular hospital diet, the low carbohydrate diet contains about double the amount of protein and fat, and about one-third the amount of carbohydrate.

SUMMARY

Based on the concept that carbohydrate-rich foods exert a depressant effect on total bodily oxygen consumption with resultant lowering of the organism's ability to overcome infection, 38 patients with pulmonary tuberculosis of varying severity were given a low carbohydrate high protein diet. Thirty-five made apparent favorable response to the diet of whom 17 showed roentgenologic improvement. The remaining 18 patients, most of whom had pneumothorax, showed no change by roentgenogram, the lesions having apparently become stabilized.

The beneficial effects of the diet are attributed to increased glucose-oxygen consumption brought about by elevation of the blood sugar to normal level in patients with hypoglycemia, and by restricting carbohydrate-rich foods in patients with hyperglycemia. The high percentage of tuberculous patients with disturbed carbohydrate metabolism as revealed by the glucose tolerance test demands correction by diet regimen.

We believe that the fundamental factor responsible for susceptibility to, and persistence of the tuberculous infection, namely, a reduced glucose-oxygen consumption, is overcome by the low carbohydrate diet. A normal carbohydrate metabolism, with concomitant normal liver glycogen stores, is an essential and fundamental mechanism upon which other defense mechanisms depend. This is true not only for the diabetic, but also for the nondiabetic. The normal combustion of glucose supplies the energy for chemical reactions needed for the production of tissue and humoral immunological substances. In addition, the high protein intake makes available chemical substances more suitable for tissue repair.

The favorable response to the diet by patients who show normal glucose tolerance curves may be attributed to an increase in liver glycogen stores with resultant improved carbohydrate metabolism. Experimental evidence is cited to show that ingestion of so-called "balanced" diets containing ample amounts of carbohydrate-rich foods do not necessarily produce normal glycogen storage and may even bring about fatty and fibrotic livers. Recent clinical reports describing good results in the treatment of cirrhosis of the liver with high protein diets further attest to the superiority of protein over carbohydrate in maintaining normal liver glycogen storage.

RESUMEN

Basándose en el concepto de que los alimentos ricos en carbohidratos ejercen un efecto depresor en el consumo corporal del oxígeno resultando una disminución de la capacidad orgánica para dominar la infección, se sujetó a 38 enfermos de tuberculosis de gravedad diversa, a una dieta baja en carbohidratos y elevada en proteínas. Treinta y cinco respondieron de modo favorable a la dieta, de los que 17 mostraron mejoría radiológica. Los restantes 18 enfermos, la mayoría con neumotórax, no mostraron cambio a los rayos X; las lesiones al parecer se hallaban estabilizadas.

Los efectos benéficos de la dieta se atribuyen al aumento del consumo de oxígeno-glucosa acarreado por la elevación del azúcar sanguínea hasta el nivel normal en enfermos con hipoglicemia y por la restricción de los alimentos ricos en carbohidratos en enfermos con hiperglicemia. El elevado porcentaje de enfermos tuberculosos que tienen trastornos del metabolismo de los hidrocarbonados se revela por las pruebas de la tolerancia de la glucosa y tales deficiencias necesitan corregirse por la alimentación.

Creemos que el factor fundamental responsable de la susceptibilidad y persistencia de la infección tuberculosa o sea el reducido consumo de oxígeno-glucosa, se domina por la dieta escasa en hidrocarbonados. El metabolismo de carbohidratos normal con almacenanormal concomitante de glicógeno es un mecanismo esencial y fundamental sobre el que reposa la defensa.

Esto es verdad no solo para el diabético sino para el no diabético. La combustión normal de la glucosa proporciona la energía para las reacciones químicas requeridas para la producción de tejidos y para las substancias humorales inmunobiológicas. Además, el elevado aporte de proteínas proporciona las substancias necesarias para la reparación tisular.

La respuesta favorable de los enfermos a la dieta que tienen curvas de glucosa normales, puede ser atribuída a aumento de glicógeno en el hígado con mejoría del metabolismo de carbohidratos.

Se cita la evidencia experimental que muestra que la ingestión de las llamadas dietas "equilibradas" que contienen gran cantidad de alimentos ricos en carbohidratos no producen almacenamiento normal de glicógeno y aún pueden conducir a la formación de hígados grasos y fibrosos.

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The Action of PAS on the Tuberculous Empyemata During the Artificial Pneumothorax Treatment*

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Clinical experience has shown that tuberculous empyema occurring during pneumothorax treatment is a serious complication. Its evolution is slow and its effect on the whole organism is unfavorable through amyloid degeneration and bad final outcome.

The authors insist that there can not be any possible parallelism between the tuberculous pulmonary lesions which may be favorably influenced and the unfavorably pleural process (cases where there is a bronchopleural fistula as a consequence of lung-ruptures being excluded).

Every clinical therapeutic method must be used before one resorts to surgical treatment.

In most tuberculous empyemata cases, frequent aspiration and lavage of the pleural cavity with antiseptic and antibiotic (penicillin) solutions, do not bring about the healing of those effusions through resorption.

Of course, there are cases in which after many months of systematic application of conservative treatment (aspiration, lavage of the pleural cavity, intrapleural injections) the cure was complete and the empyema resorbed. But even in cases with favorable results there is the disadvantage of pleural sclerosis, provoked through the repeated antiseptic lavages and consequent irritation which hinders the reexpansion of the lung. In such cases the pleural cavity remains under negative manometric pressure which can provoke the ex vacuo reappearance of an exudate.

Lehmann was the first (1946) to prove the bacteriostatic action of PAS on tubercle bacilli. This was confirmed by Youmans as well as the bacteriostatic actions in vitro of the drug on streptomycin-resistant tubercle bacilli.

A review of the international literature concerning the application of PAS on empyemata shows: Wilhelm, 10 cases. After 4 PAS (aminocyl) injections no bacilli were found in the micro-

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scopic examination. In most of the cases the empyema became less thick and in two quite clear, its quantity having diminished at the same time. Dempsey and Logg administered aminacyl in nine empyema cases. In three of them there were fistulae of the chest wall, in one a broncho-pleural fistula together with one of the chest wall. In a fifth case there was only a broncho-pleural fistula. The results were satisfactory.

Valentin treated 10 cases with cure in four, stationary state in three, and fatal outcome in three. Steinlin had five cases with complete disappearance of tubercle bacilli from the pus after a few weeks of aminocyl therapy. Sivriere reported satisfactory results in six cases. Steinlin and Wilhelm treated 34 cases among whom 26 had disappearance of tubercle bacilli, and in eight there was resorption of the effusion. Coumoulos observed satisfactory results in three cases of empyemata with fistulae of the chest wall.

We administered the aminocyl (Wander) treatment in 17 cases of empyema, 11 of whom had artificial pneumothorax complicated by sero-fibrinous effusion, which later became empyematous. In four of them (empyema for one month in two, six weeks in one, and four months in the last) the empyema was resorbed in a short time. In two cases the pneumothorax pocket was preserved, allowing the continuation of insufflation. In the other two cases, following resorption of the empyema, the lungs reexpanded and adhesions developed.

In the remaining seven of the 11 cases (empyema existed for only a few days in two, and for 2, 5, 22, 24 and 42 months in the other five) we have the following results: In three the empyema's consistency showed a diminution in thickness while in three others it became serofibrinous and in one no change was observed. In all of these seven cases the aminocyl treatment has been continued. In the remaining three of the 17 cases artificial pneumothorax was complicated by broncho-pleural fistulae. In one of them a chest wall fistula was also present. The aminocyl treatment was without effect in these three cases.

The last three cases consisted of one which had been drained for 21 months and showed only diminution of the empyema after 21 ampouls of 10 ccm. aminocyl were administered. Another case with empyema following extrapleural pneumothorax and the third with multiple chest wall fistulae which developed 10 years after thoracoplasty were not benefitted.

SUMMARY

1) Seventeen patients with tuberculous empyema complicating artificial pneumothorax were treated with PAS.

2) The effect of aminacyl on closed empyemata can be generally

considered as satisfactory, although it differs in degree from one case to another.

3) Complete cure, through resorption of the effusion occurred in a small percentage (4 in 11 cases), but more rapidly than through the usual therapeutic methods.

4) The effect on fistulae is not satisfactory judging from our three cases.

5) Better results may be obtainable when the drug is available for larger and more frequent doses.

RESUMEN

1) Diecisiete enfermos con empiema tuberculoso complicando neumotórax artificial fueron tratados con PAS.

2) El efecto del aminacil en los empiemas cerrados puede ser considerado en general como satisfactorio aunque difiere en grado de un caso a otro.

3) La completa curación por reabsorción del derrame ocurre en un pequeño porcentaje (cuatro de 11 casos) pero más pronto que por los métodos terapéuticos usuales.

4) El efecto sobre las fístulas no es satisfactorio a juzgar por nuestros tres casos.

5) Mejores resultados son de esperarse cuando la droga pueda obtenerse para dosis mayores y más frecuentes.

Experimental Studies on the Repair of Wounds and Defects of the Trachea and Bronchi*†

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In a previous publication[1] we described the use of rigid tubes to replace defects in the tracheas of dogs. These defects were created by the removal of segments of the entire tracheal wall, which varied in length from one to 13 cartilage rings. The segments of trachea were replaced by rigid tubes made of glass or metal having a flange at each end. These tubes were tied in place by ligatures as is shown in Figure 1. Fifteen animals survived the operative procedure and the tubes were tolerated well by all except one. The tube became displaced in that animal and caused partial obstruction of the trachea. The remaining 14 dogs were sacrificed at intervals of from two weeks to six months after operation.

Examination of the tracheas when the animals were sacrificed showed that the tubes were held firmly in place by surrounding fibrous tissue and granulation tissue. The ligatures had cut through the trachea and were lying against the tubes in all of the animals. The trachea and the tube usually contained small amounts of thick mucus. The tissue which lay against the outer surface of the tube was firm, smooth and glistening.

Microscopic sections of the specimens were cut longitudinally through the tissue which surrounded the tubes and the wall of the trachea above and below the defects. These sections revealed granulation tissue which was densely infiltrated with leucocytes, and conversion of the deeper (or outside) portion of the newly-formed airway into dense scar tissue. Scattered irregularly through the granulation tissue were small islands of cartilage cells, which had no demonstrable connection with the rings of cartilage in the trachea above and below the defect (Figures 2 and 3). In

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some specimens the islands of cartilage tended to grow in the form of delicate rings extending around the circumference of the tube. In others this did not appear to be true, the islands being smaller and shorter. In all cases the islands or "rings" of cartilage were irregular in outline and delicate in appearance.

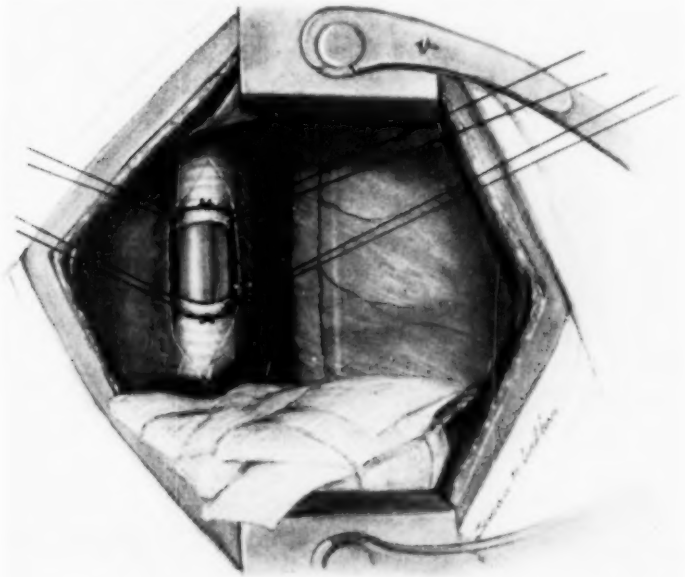

FIGURE 1: Showing method of fixation of tube to bridge defects in the dogs trachea. The tube has a flange at each end about 1.5 mm. high.

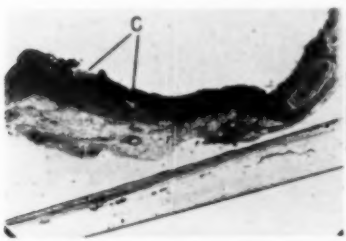

FIGURE 2

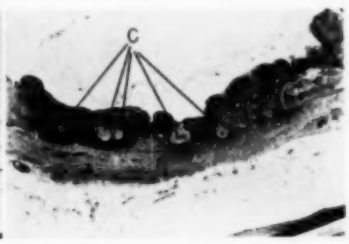

FIGURE 3

Fig. 2: Dog No. 2-13—Photomicrograph of dog sacrificed three weeks after excision of a segment of trachea which was replaced by a metal tube. (C): New cartilage growing in granulation tissue (about x 10).—*Fig. 3:* Dog No. 326—Sacrificed eight weeks after replacement of a segment of trachea by a metal tube. Photomicrograph (about x 12) showing one old cartilage ring and several new poorly developed rings in granulation tissue (C) which were cut at right angles; early regrowth of epithelium can be seen at one end of section.

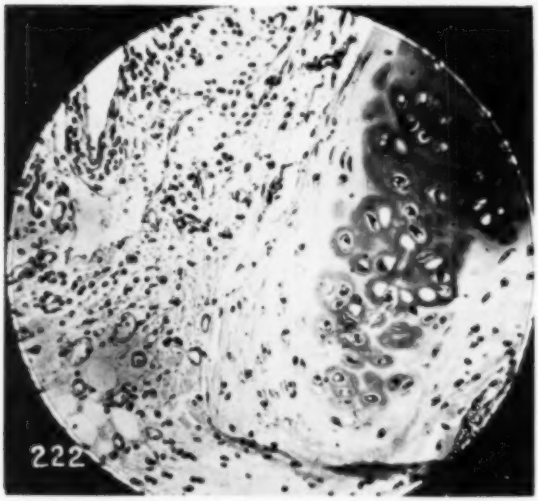

FIGURE 4: Photograph (about x 200) showing cartilage which has grown from fibroblasts surrounding metal tube used to bridge defect in the trachea—6½ weeks after operation.

FIGURE 5: Photomicrograph (about x 400) of edge of island of cartilage growing in granulation tissues. Dog sacrificed six months after steel tube was fixed in defect of the trachea.

Examination of the borders of the islands of cartilage showed a gradual transition from fibroblasts in the granulation tissue to cartilage cells. The fibroblasts appeared to have been the anlagen of the cartilage cells (Figures 4 and 5).

In several other animals the right lung, the lower end of the

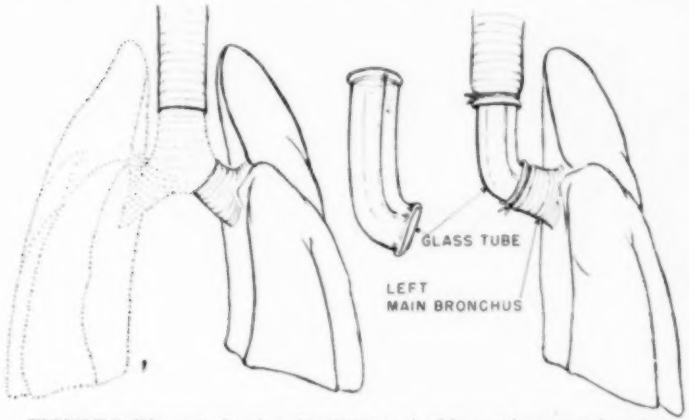

FIGURE 6: Diagram showing structures excised in previous experiments. The method of fixation of the flanged glass tube is illustrated.

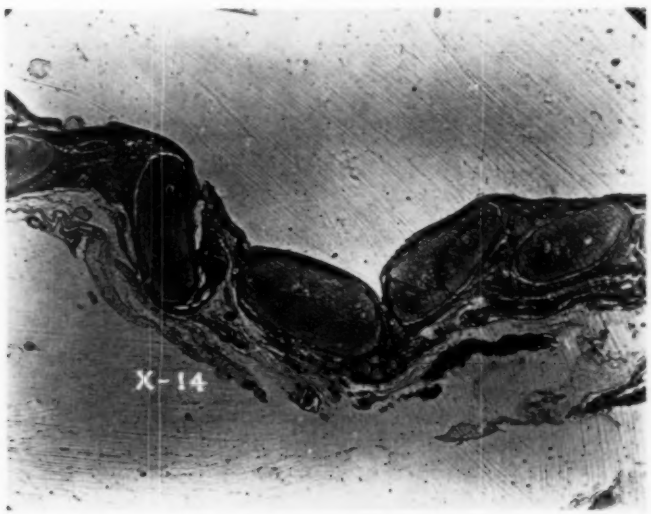

FIGURE 7: Photomicrograph (about x 10) showing wall of regrown trachea in animal which had right pneumonectomy with the removal of the lower end of the trachea—14 months after operation.

trachea and the upper end of the left main bronchus were excised "en bloc." The defect between the trachea and left bronchus was bridged by curved tubes (Figure 6). Two dogs survived this procedure. The tube was removed from one animal after eight months by means of the bronchoscope. The animal remained well and was sacrificed six months after removal of the tube. A well developed, though somewhat narrow, tube extended from the normal trachea to the left main bronchus. Well developed rings of cartilage were present and the mucous membrane was intact (Figure 7).

Since the publication of the experiments outlined above, further studies have been carried out on the healing of wounds of the trachea:

Methods

Mongrel dogs were used. All operations were carried out under aseptic conditions employing sodium - pentobarbital anesthesia, administered intravenously. Intermittent intracheal insufflation of air was used in all operations upon the thoracic trachea. Autopsy was performed upon all animals which died or which were sacrificed. The trachea, the adjacent mediastinal structures, and the lung were examined. Photographs of many of the specimens were taken and microscopic sections of the trachea were obtained.

The following groups of experiments were carried out:

I. Simple longitudinal incisions: three dogs. The trachea was

TABLE I

Transection of Trachea

Dog No.	Location of Anastomosis	Cause of Death of Animal	Time After Operation	Findings Postmortem
55	Thoracic trachea	Sacrificed	21 days	Well healed—No stenosis
56	Thoracic	Sacrificed	14 days	Well healed—No stenosis
32	Thoracic	Sacrificed	28 days	Well healed—Very slight stenosis
70	Cervical	Sacrificed	21 days	Well healed—Slight stenosis
71*	Cervical	Sacrificed	28 days	Firmly healed—Moderate stenosis
81**	Cervical	Sacrificed	11 days	Very marked stenosis
82**	Cervical	Sacrificed	8 days	Very marked stenosis

*Moderate wheezing and respiratory distress before death.
**Animal had very marked respiratory distress before death.

exposed in the mediastinum and longitudinal incisions were made through the anterior wall, across three cartilages. The incisions were closed with one row of fine interrupted sutures of silk. The animals were sacrificed at the end of 10, 14 and 28 days after operation.

II. Transection of the trachea: seven dogs. Two groups of experiments were carried out.

(a) In four dogs the trachea was exposed in the neck and was completely divided, the incision being carried between cartilage rings. In two of these, three-ring segments were completely removed. The divided ends were brought together and sutured in place with on row of interrupted fine silk sutures, placed close together (See Table I).

(b) In three other animals the thoracic trachea was exposed through an intercostal, transpleural approach on the right side and the trachea was divided. The ends were brought together with sutures in the same manner as above.

III. "Window" grafts: 14 dogs.

(a) In four dogs windows about 1 cm. square (which included three cartilage rings) were removed from the anterior wall of the thoracic trachea and then were placed back into the defect and sutured in place with fine silk (See Table II).

(b) In nine other animals windows which varied in length but which were all 1 cm. square and included portions of three cartilage rings were removed and were replaced by grafts of the same size which were removed from other dogs (See Table III). Six were in the thoracic trachea and three in the cervical trachea.

Those animals which did not die were sacrificed at intervals varying from 13 to 30 days.

TABLE II

Window Grafst: Full Thickness, Replaced by Suture in Same Animal Thoracic Trachea

Dog No.	Time of Death After Operation	Cause of Death	Findings Postmortem
44	14 days	Sacrificed	Moderate contracture of window and stenosis of trachea. Graft rigid scar, no cartilage.
45	21 days	Sacrificed	Window soft and pliable. No stenosis. Partial resorption of cartilage.
10	28 days	Sacrificed	Graft rigid. No contracture of window or stenosis of trachea. Complete resorption of cartilage.
102	19 days	Sacrificed	Graft pliable—contracted slightly. Slight stenosis of trachea. Resorption of most of cartilage. ? growth of new cartilage in graft.

IV. Full-segment grafts: 18 dogs. Two groups of experiments were performed.

(a) In each of two animals the thorax was opened through an intercostal incision on the right and the trachea was exposed and transected in two places, a segment composed of three rings being completely removed. This segment was then put back in place and was sutured to the divided ends of the trachea with interrupted fine silk sutures. The animals were sacrificed 19 and 21 days after operation.

In nine other dogs the trachea was exposed in the neck and the same procedure described above carried out in three. In the remaining six animals irregular incisions were made when the trachea was divided, in such a way that in three animals the graft had a V-shaped flap at one end and in three others the

TABLE III

Window Grafts: Full Thickness, Removed From Other Animals

Dog No.	Location of Defect	Time of Death After Operation	Cause of Death
99	Cervical trachea	25 days	Sacrificed
	Findings Postmortem: Slight stenosis of trachea. Graft rigid. Partial resorption of cartilage. No epithelium present.		
100	Cervical trachea	27 days	Sacrificed
	Findings Postmortem: No stenosis. Graft rigid. Flattened epithelium present over most of graft. Cartilage rings appear normal.		
105	Cervical trachea	18 days	Sacrificed
	Findings Postmortem: No stenosis. Graft pliable—Partial resorption of cartilage rings.		
68	Thoracic trachea	4 days	Died—tracheal obstruction
	Findings Postmortem: Disruption of suture line at side of window.		
85	Thoracic trachea	13 days	Sacrificed
	Findings Postmortem: Well healed. Trachea oval shaped. Window soft. No stenosis. Graft composed of scar. No cartilage in graft.		
72	Thoracic trachea	21 days	Sacrificed
	Findings Postmortem: Well healed. Trachea normal shape. No stenosis. ? growth of new cartilage in transplant.		
69	Thoracic trachea	28 days	Sacrificed
	Findings Postmortem: Transplant soft. Trachea oval in shape. No stenosis or contracture. Complete resorption of cartilage.		
103	Thoracic trachea	24 days	Sacrificed
	Findings Postmortem: No stenosis. Trachea looks almost entirely normal. Epithelium flattened but intact. Slight fragmentation of cartilage.		
104	Thoracic trachea	24 days	Sacrificed
	Findings Postmortem: Slight stenosis. Graft protruding into lumen of trachea. Marked inflammatory reaction. Cartilage sloughing from graft.		

V-shaped flap was created at both ends of the segment which was removed. These segments were all fitted back exactly into the defects and sutured in place with one row of interrupted fine silk sutures.

The animals in this group died or were sacrificed at intervals varying from eight to 15 days.

(b) In seven dogs segments of trachea composed of three cartilage rings were transferred from one dog to another. In three experiments the thoracic trachea was grafted. In four others the cervical trachea was used and in two of these V-shaped flaps were made at one end of the grafts as was described above.

The animals in this group of experiments died or were sacrificed in from 13 to 28 days.

Results

Group I: The longitudinally incised wounds in the anterior walls of the trachea healed smoothly and without evidence of infection. The cut ends of the cartilage appeared to have adherred to each other by growth of fibrous connective tissue. The mucous membrane was intact and there was only a very slight longitudinal ridge on the inner surface of the trachea to indicate the site of incision.

Group II: These experiments are summarized in Table I. The appearance of the trachea at the site of its division was greatly different in the two groups of experiments. In sub-group (a) in which the trachea was divided in the neck, marked stenosis of the trachea was present in all. The wounds were firmly healed in all cases but the amount of stenosis which was present was great enough to markedly embarrass the respiration of the animal and in all but one instance the animal was sacrificed because of respiratory distress. The stenosis was concentric and sharply defined. In all instances the lumen of the trachea at the point of stenosis was less than half the diameter of the normal trachea above and below the stricture. In the second group of three animals (b) in which the incision was made through the trachea in the thorax, there was slight stenosis in one and no stenosis in the other two (Figures 8 and 9).

The wounds were well healed in all animals. None of them exhibited wheezing or evidence of respiratory distress before they were sacrificed. In all cases the mucous membrane was intact.

Group III: Very little difference could be seen in the behavior of the animals in the two sub-groups. One animal (No. 68) died on the fourth postoperative day. Autopsy revealed disruption of the suture line at the side of the window. The remaining dogs were sacrificed in order to examine the tracheas. None of these

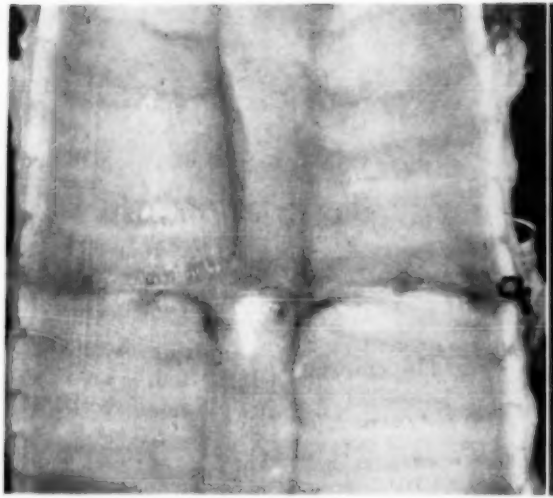

FIGURE 8

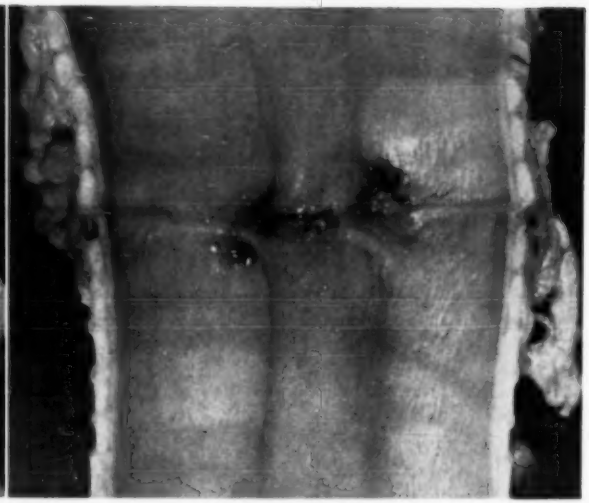

FIGURE 9

Fig. 8: Dog No. 55—Transection of thoracic trachea and end-to-end suture. Thoracic trachea—three weeks after operation.—*Fig. 9:* Dog No. 56—Excision of three-ring segment and end-to-end suture of the two tracheal segments. Two weeks after operation—thoracic trachea.

animals showed evidence of respiratory distress before being sacrificed. The findings of these experiments are summarized in Tables II and III. In six of the animals the cartilage in the graft had disappeared. There appeared to be a gradual resorption of the cartilage, from its edges inward toward the center of the ring, with replacement of the cartilage by fibrous connective tissue.

FIGURE 10: Dog No. 10—Excision of window 1 cm. square and replacement by suture in same dog. Four weeks after operation.

FIGURE 11: Dog No. 10—Same as Figure 10. Inner surface of trachea. Arrows indicate corners of graft.

There appears to have been no difference in those animals in which homoplastic grafts were used as compared to those in which autoplastic grafts were employed. There was a variable leukocytic infiltration of the tissues within the graft. In most cases the grafts were grossly softer and more pliable in texture than was the surrounding tracheal wall. It is believed that in most of the experiments the graft acted as a scaffold for the in-growth of new fibrous connective tissues from the margin of the defect in the trachea. It was impossible, however, to be certain of this observation from a study of the microscopic sections. Indeed, in two experiments the grafts appeared grossly and microscopically to be identical with the normal tracheal wall above and below the defects (Dogs Nos. 100 and 103). Both of these were homoplastic transplants. In most of the experiments there was no evidence of stenosis at the site of operation. In some animals the trachea assumed an oval shape at the site of graft, being flattened in its antero-posterior diameter (Figures 10, 11 and 12).

Two factors were, in all probability, brought to play in the prevention of stenosis of the trachea in this group of experiments, regardless of whether autoplastic or homoplastic grafts were used. The first of these has to do with the nature of the tracheal cartilage itself. As was pointed out by Moskoff,[2] the tracheal cartilage ring can be compared to a drawn bow with the transverse tracheal muscle acting as the string. This muscle not only connects the ends of the cartilage but is also capable of drawing the latter closer together. The outer perichondrium exerts traction on the

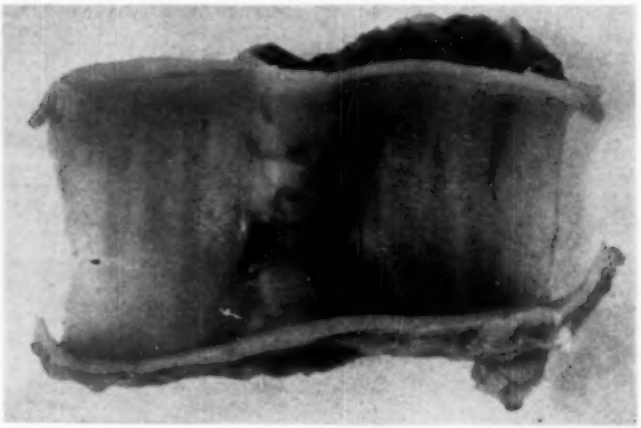

FIGURE 12: Dog No. 72—Excision of window 1 cm. square and replacement with full-thickness graft from another dog. Thoracic trachea—three weeks after operation.

outer surface of the cartilage ring in such a way as constantly to draw the cartilage toward a straight position. The second factor which probably played a part in preventing stenosis was the splinting effect of the cartilage rings above and below the graft.

Group IV: (a) The two animals in which full-thickness segments of the thoracic trachea were removed and then sutured back in place had no recognizable respiratory difficulty following operation. They were both in excellent health when sacrificed. Autopsy revealed both incisions, at the upper and lower ends of

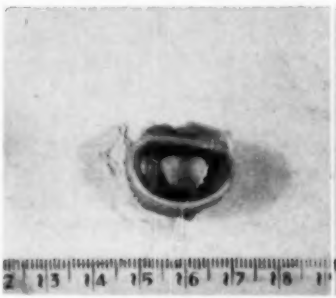

FIGURE 13

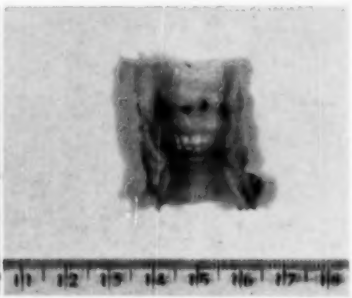

FIGURE 14

Fig. 13: Dog No. 110—Segment of thoracic trachea 1 cm. long and including three cartilage rings removed and then replaced by suture in the same dog. Sacrificed 19 days after operation.—*Fig. 14:* Dog No. 111—Autoplastic graft, complete circumference of thoracic trachea, as in Fig. 13. Animal sacrificed 21 days after operation.

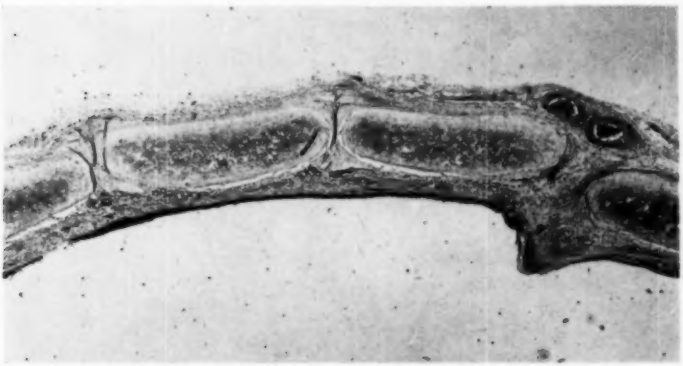

FIGURE 15: Dog No. 111—Autoplastic graft, full circumference of thoracic trachea. Animal sacrificed on twenty-first postoperative day. The line of healing of the graft to the adjacent tracheal wall is marked by the silk sutures. The graft is to the left of the sutures. Photomicrograph (about x 15).

the grafts, to be firmly healed. The mucous membrane appeared to be intact and there was a small ridge which encircled the trachea on the inner surface which marked the lines of incision. No stenosis was present (Figures 13 and 14). The three cartilage rings within the graft were grossly normal in appearance. Microscopic sections, made by cutting the trachea longitudinally across the cartilage rings, revealed tracheal wall which was remarkably normal in appearance. In one experiment (No. 110) the epithelium appeared to be fragmented in some areas, while in the other (No. 111) it appeared to be entirely normal. In both there

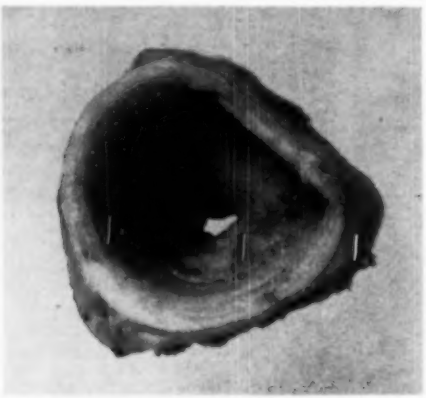

FIGURE 16: Dog No. 74—Nine days after excision of three-ring segment and replacement in same animal—cervical trachea.

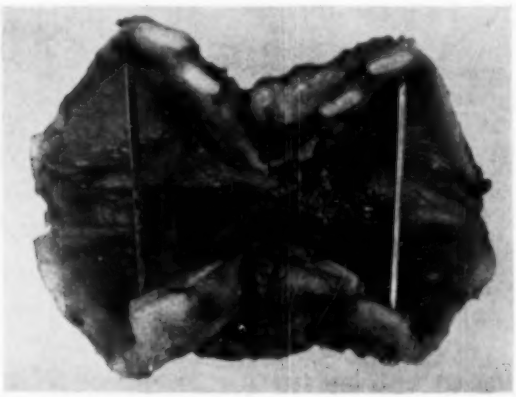

FIGURE 17: Dog No. 73—Fifteen days after excision of three-ring segment and replacement by suture in same dog—Cervical trachea.

was a moderate inflammatory reaction at the lines of healing, which were marked by the silk sutures. There was no cellular infiltration in the graft away from the suture line, however. The cartilage rings appeared to be normal (Figure 15).

Marked stenosis of the trachea occurred in all of the nine animals in which full-segment grafts were removed and replaced in the cervical trachea (Figures 16 and 17). A few of these animals died as a result of tracheal obstruction but the majority of them were sacrificed because of marked respiratory distress. Examination of the specimens revealed the stenosis to be very marked in all of them. The contracture was irregularly concentric. The distance between the cut ends of the trachea, (that is, the distance occupied by the graft itself) appeared to be greatly shortened and in many animals the graft appeared to be buckled upon itself or to be over-riding the inner surface of the trachea above or below the defect. Purulent exudate was present in the trachea below the area of stenosis in many of these animals. Microscopic sections revealed almost complete disappearance of the cartilage rings in almost all of the animals. There was extensive leukocytic infiltration of the graft and the epithelium had disappeared in all of the animals. Fibroblasts were growing into the grafts apparently from the cut edges of the trachea above and below the defect. The stenosis was as marked in those animals in which irregular or V-shaped incisions were made as in those in which a straight transection of the trachea was carried out.

(b) In *sub-group b* in which segments of trachea were transferred from one animal to another, the same results were obtained as described in the paragraph above. Stenosis was present in all of these animals and most of them were sacrificed because of marked tracheal obstruction. Microscopic sections revealed destruction and absorption of the cartilage rings, disappearance of the mucous membrane and extensive leukocytic infiltration of the connective tissues.

SUMMARY

Full-thickness segments of the trachea have been removed from dogs and the defects bridged by glass or metal tubes. The tubes were tolerated well by most animals. Examination of the tissue about these tubes at intervals of from two weeks to 14 months following operation revealed that small islands and rings of new cartilage were growing in the granulation tissue. It is believed that this cartilage develops from fibroblasts growing in the granulation tissue.[1]

Several other types of operative procedure have been carried out on dogs. The following observations were made:

1) Longitudinal incisions in the dog's trachea heal without residual deformity of the tracheal wall. Complete transverse division of the trachea and end-to-end suture results in healing with rather marked stenosis in the neck whereas firm healing occurs with much less evidence of stenosis in the thoracic trachea.

2) Transplants of patches of tracheal wall, about 1 cm. square and containing parts of three tracheal cartilages were successfully used to fill defects of similar size. These grafts appeared to be tolerated equally well whether taken from the same animal or transplanted from the tracheas of other dogs. The cartilage gradually disappeared from most of these transplants, the grafts finally being composed of fibrous tissue. In two animals the cartilage did not change in appearance and in two others it appeared that new cartilage was being formed.

3) Segments of the entire trachea, 1 cm. long, which contained three cartilage rings were removed from the thoracic trachea of two dogs and then replaced by suture. These animals had no respiratory difficulty after operation and were sacrificed at the end of three weeks. The incisions were found to be well healed and histological examination revealed the tissues in the grafts to be normal in appearance.

Similar transplants in the cervical trachea became partly necrotic and were rapidly replaced by scar, with contracture of the graft and marked stenosis of the trachea. Transplants from one animal to another, in both the cervical and thoracic portions of the trachea, also were replaced by scar and in those animals stenosis developed so rapidly that most of the dogs were sacrificed within two weeks of the operation because of respiratory obstruction.

RESUMEN

Se han extirpado segmentos enteros de las tráqueas de perros y los defectos resultantes han sido reparados por medio de tubos de vidrio o de metal. La mayor parte de los animales toleraron bien los tubos. Exámenes de los tejidos alrededor de estos tubos a intervalos de dos semanas a 14 meses después de la operación revelaron que islas y anillos de nuevo cartílago estaba creciendo en el tejido de granulación. Se cree que este cartílago se origina en fibroblastos que crecen en el tejido de granulación.[1]

Se han llevado a cabo en los perros varios otros tipos de procedimientos operatorios. Se hicieron las siguientes observaciones:

1) Incisiones longitudinales en la tráquea del perro se cicatrizan sin dejar deformidad en la pared traqueal. La completa división transversal de la tráquea y la sutura de extremidad a extremidad resulta en cicatrización con estenosis bastante mar-

cada en la tráquea cervical, mientras que cicatrización firme con mucha menor evidencia de estenosis resulta en la tráquea torácica.

2) Transplantaciones de pedazos de la pared traqueal como de un centímetro quedrado y que contenían partes de tres cartílagos traqueales fueron usados con buen éxito para llenar defectos de tamaño semejante. Pareció que se toleraron igualmente bien estos injertos ya sea que se tomaron del mismo animal o fueron transplantados de las tráqueas de otros perros. El cartílago desapareció paulatinamente de la mayoría de estos transplantes hasta que al fin se componían los injertos de tejido fibroso. En dos animales no cambió el aspecto del cartílago y en otros dos pareció que se estaba formando nuevo cartílago.

3) Se extirparon segmentos de la tráquea entera, 1 cm. de largo, que contenían tres anillos cartilaginosos, de la tráquea toracica de dos perros y fueron reemplazados después con suturas. No tuvieron estos animales dificultades respiratorias después de la operación y fueron sacrificados al fin de tres semanas. Se encontró que las incisiones estaban bien cicatrizadas y el examen histológico reveló que el tejido de los injertos tenía un aspecto normal.

Transplantos semejantes en la tráquea cervical se volvieron en parte necróticos y fueron reemplazados rápidamente por cicatrices, con contracción del injerto y marcada estenosis de la tráquea. Transplantes de un animal a otro, tanto en la parte cervical de la tráquea como en la torácica, también fueron reemplazados por cicatrices y en esos animales se desarrolló la estenosis con tanta rapidez que hubo que sacrificar a la mayor parte de los perros en menos de dos semanas después de la operación debido a obstrucción respiratoria.

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Pulmonary Tuberculosis in University of Buffalo Medical Students

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The fact that pulmonary tuberculosis is an occupational hazard for medical students became rather obvious following the reports of Hetherington,[1] Soper and Amberson,[2] and Myers.[3] The incidence varied according to the geographic area, diagnostic criteria, and methods of survey but in nearly all instances the development of significant disease was higher than in the same age groups of the general population. In schools where no formal case detecting program was maintained, new cases usually progressed beyond the incipient stage and were unsuspected until manifest symptoms had developed and the disease had reached the moderately advanced or advanced stage. The student not only would be forced to interrupt his training but all too frequently he would find it necessary to give up his plans for a medical career. As other students became aware of these hazards phthisophobia frequently developed and services on tuberculosis wards and externships in sanatoria became undesirable.

In the University of Buffalo Medical School there appeared to be an unduly high incidence of significant pulmonary tuberculosis and in 1942 a survey program was instituted with the threefold purpose of: 1) Discovery of new cases of pulmonary tuberculosis while still in the incipient stage. 2) Checkup of the tuberculin conversion rate. 3) Better indoctrination of the students with regard to early diagnosis and treatment of pulmonary tuberculosis. The following is a summary of the methods used and the findings over a period of four years.

Method

During July 1942 the new program was instituted through the cooperation of the medical school, the Buffalo and Erie County Tuberculosis Association and Doctors E. C. Koenig and G N.. Scatchard, roentgenologists at the Buffalo General Hospital and

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E. J. Meyer Memorial Hospital, respectively. Every student, regardless of tuberculin reaction, was required to report three times each school year for a chest x-ray. It was arranged that the upperclassmen might report to the x-ray department of the hospital to which they happened to be assigned. Freshmen and sophomores reported alternately at the Buffalo General and E. J. Meyer Memorial Hospitals. All films were checked by two and, in many cases, by three examiners. During the school year 1946-1947 a 70 mm. photoroentgen unit became available and the survey films were made by bringing this unit to the school and hospitals. The entire student body could be checked in one day by this method. All suspicious or doubtful findings were checked by recalling the individual concerned for conventional 14 x 17 inch roentgenograms. When the chest films demonstrated definite, or questionable changes further clinical studies were made in the form of temperature records, blood studies, culture of sputum or gastric contents and serial chest x-rays. If the diagnosis was confirmed or if suspicious findings persisted, a conservative program was followed which usually meant withdrawal from school and admission to a sanatorium.

Tuberculin tests were done once each school year, first strength Old Tuberculin (0.01 mg.) being used during 1942 and 1943 but first strength Purified Protein Derivative Tuberculin (0.00002 mg.) during the remainder of the study. All tuberculin tests were administered and read by one individual and the same person was designated as a part time physician to carry out the mechanics of the plan, review survey films and to be available to any students who developed pulmonary symptoms. The period covered by this report extended from July 1942 through June 1946 and the total number of students included in the study was 679.

Incidence of Significant Disease

During the four year period of observation 11 cases of significant pulmonary tuberculosis and one case of tuberculous pleural effusion were discovered, the over-all incidence being 1.8 per cent. Two students suffered relapses during their internships but there were no fatalities. Our incidence of 1.8 per cent compares favorably with the 2.2 per cent incidence in Harvard Medical School as reported by Brean and Kane[4] but Morris[5] found the clinical morbidity rate to be 12.5 per cent at Women's Medical College of Pennsylvania. The opposite extreme has been noted by Myers[6] who reports only one medical student with clinical pulmonary tuberculosis during a period of four years.

As shown in table 1, five students were discovered during the first year, three during the second year, none during the third

TABLE 1

School Year and Extent of Tuberculosis at Time of Diagnosis

Entrance Date	SCHOOL YEAR WHEN LESION FIRST APPEARED				CLASSIFICATION OF LESION AT DIAGNOSIS					
	First	Second	Third	Fourth	Unilateral	Bilateral	Minimal	Moderately advanced	Far advanced	Tuberculous Pleural Effusion
Oct. 1941	1	2		1	3		4			
July 1942	2			1	2	1	2	1		
June 1943										
April 1944	1			2	3		2	1		
Jan. 1945	1				1		1			
Oct. 1945		1			1		1			1
Sept. 1946										
TOTALS	5	3	0	4	10	1	10	2	0	1

year, and four during the fourth year. The apparent high incidence in the freshman year is partially due to the fact that two students who presumably entered school with significant disease and who were discovered in the first survey are included in this group. Likewise, the one case of moderately advanced disease in a freshman was discovered the first time he was examined after entering medical school. The other student with moderately advanced disease is noteworthy as a graphic illustration of the need for frequent examinations.

This 23 year old senior student is the son of a sanatorium superintendent but he had little contact with any of the patients. During August of the year in question a routine 14 x 17 inch chest roentgenogram was free from abnormal findings and a 70 mm. photoroentgen film during October of the same year was also unremarkable. During late November he developed slight cough, general malaise and pleuritic pain but these symptoms improved after a few days and he did not report for checkup. Just before leaving on his Christmas vacation he coughed up a small amount of sputum which was definitely foul. Chest x-ray inspection at this time demonstrated a $2\frac{1}{2}$ cm. area of rarefaction with surrounding pneumonitis in the upper portion of the right lower lobe. Sputum samples were positive for acid fast bacilli on direct smear examination and pathogenicity was established by guinea pig inoculation.

On a bed rest regimen, the exudative lesion cleared rapidly and the area of cavitation could no longer be visualized four months after treatment had been instituted. The student has been able to return to school, complete his course and begin an internship.

The rapidity of both development and clearing of the exudative disease and cavitation brought up the question of possible acute abscess with subsequent breakdown of an old primary complex. The important point to us, however, was the proof that checkup chest x-ray inspection at intervals as short as three months will not guarantee discovery of all tuberculous lesions in the incipient stage.

SUMMARY OF TABLE II

Survey of Medical Students

University of Buffalo Medical School

1. Cases of pulmonary tuberculosis found by survey			11
School year in which discovered:			
First year	5		
Minimal	4. moderately advanced		1
Second year	2		
Both minimal cases.			
Third year	0		
Fourth year	4		
Minimal	3. moderately advanced		1
2. Cases of tuberculous pleural effusion			1
Discovered during second year.			

Disposition of New Cases

Three of the 12 newly diagnosed students were able to continue their school course and graduate without complications. Eight of the remaining nine patients entered sanatoria for varying periods but only one required collapse therapy. Eleven of the 12 students have been able to return to school and they have either graduated or are in attendance at the present time. All of the students have been cooperative and willing to accept recommendations even though this frequently meant withdrawal from school and admission to a sanatorium.

Tuberculin Reactions

In table 3 we have shown the mean age of the Freshman classes, the highest average for any one class being 24.4 years while the lowest was 21.2 years. The percentage of Freshmen who entered with positive tuberculin tests varied from 15 to 37 per cent. The comparatively low percentage of reactors was thought due to: 1) A large number of students come from small cities and rural areas. 2) Use of first strength Purified Protein Derivative Tuberculin. We believe this percentage of reactors is near the average for this section of New York state, however, since Terplan[7] has reported that primary complexes could be demonstrated by anatomic method in only 19.4 per cent of 113 autopsies performed at the Buffalo General and Buffalo Childrens Hospitals on patients in the age group of 7 to 18 years.

The rate of tuberculin conversion did not increase rapidly during

TABLE III

Tuberculin Tests — Rate of Conversion

Entrance Date	Mean Age at Entrance	First Year Per cent Positive	Second Year Per cent Positive	Third Year Per cent Positive	Fourth Year Per cent Positive
Oct. 1939	24.4			39	52
Sept. 1940	23.5	24	29	39	44
Oct. 1941	22.8	37	39	43	45
July 1942	21.8	28	42	51	60
June 1943	21.5	20	25	27	33
April 1944	21.2	15	20	35	43
Jan. 1945	21.8	15	15	24	
Oct. 1945	22.9	20	30		
Oct. 1946	23.6	28			
Average	22.6	23.4	28.6	37	46.2

the Junior and Senior years as we had expected. The average increase in percentage of reactors from the Freshman to Sophomore years was 5.9 per cent, from Sophomore to Junior 8.2 per cent, Junior to Senior 7.2 per cent. Twenty-seven per cent of those who entered with negative tuberculin reactions converted during their training period and it was found that the average number of reactors in all the Senior classes was 46.2 per cent. In this school students observe but do not take active part in postmortem examinations. Some, but not all, are assigned to the tuberculosis unit at the E. J. Meyer Memorial Hospital. There is additional contact in the out-patient departments of all hospitals and on the wards of the Buffalo General Hospital where some tuberculous patients are accepted for surgical procedures. We believe that the active participation in postmortem examinations is a definite factor in increasing the rate of tuberculin conversion. Meade[5] found in a study at the University of Rochester that there was a marked decrease in the rate of tuberculin conversions in the second year medical students when they ceased to participate in autopsies on tuberculous individuals. He also noted a decrease in tuberculous disease so that approximately one-half as many new cases of significant disease were picked up after this change had been made in the curriculum.

Development of Significant Disease Following Tuberculin Conversion

Significant tuberculous disease developed in seven of the 12 cases one year or less after the discovery of tuberculin conversion. This has led some observers[4] to recommend that when students become new reactors, x-ray inspection of the chest should be repeated every six weeks for six months and every three months for the balance of the first year.

Discussion

Anti-tuberculosis programs in some medical schools have engendered undue apprehension on the part of the students so that, in some cases, there was reluctance to accept a service in a tuberculosis hospital or to follow known tuberculous cases in a general hospital. We have not encountered such antipathy but instead there is a healthy interest in the program and the students frequently inquire regarding the next date for checkup. There is no hesitancy about requesting special x-ray inspection if they become aware of symptoms that seem referable to the chest.

Tuberculous disease is being discovered earlier so that there is less interruption of training and only rarely the necessity to choose another career. This was one of the primary purposes of the

survey and we believe that the second purpose, better student understanding of early diagnosis and treatment of tuberculosis, has also been accomplished. X-ray checkups at intervals of more than three to four months will not unearth all incipient disease because, as in the instance quoted above, some disease reacts almost explosively.

SUMMARY

During a four year period 679 medical students were given intracutaneous tuberculin tests once annually and all, regardless of tuberculin reaction, were required to report three times each school year for a chest roentgenogram. There was an over-all incidence of 1.8 per cent significant pulmonary tuberculosis and in this group of 12 students there were two who demonstrated moderately advanced disease, nine in the minimal group and one with tuberculous pleural effusion. Five students developed their disease during the first year, three during the second year, none during the third year and four during the fourth year. One of the students with moderately advanced disease was a Freshman and his disease antedated admission to medical school since it was discovered on the first survey after admission. The percentage of tuberculin reactors in the entering Freshman classes averaged 22.6 per cent. Twenty-seven per cent of the students who entered as negative reactors became positive by the time they graduated. The average increase in percentage of reactors from the Freshman to Sophomore years was 5.9 per cent, from Sophomore to Junior 8.2 per cent, and Junior to Senior 7.2 per cent.

RESUMEN

En un periodo de cuatro años, 679 estudiantes de medicine, recibieron anualmente la vacuna cutanea tuberculosa, radiografías del tórax en todos ellos, fueron tomadas tres veces durante el año escolar, sin tener en cuenta la reacción a la tuberculina. Se comprobó que 1.8 por ciento del total, tenían tuberculosis pulmonar; en este grupo de 12 estudiantes, dos de ellos presentaron lesiones moderadas del pulmón, nueve tenían lesiones minimas y uno tenía derrame pleural tuberculoso. Cinco estudiantes contrajeron la enfermedad durante el primer año, tres durante el segundo año, ninguno durante el tercer año y cuatro durante el cuatro año. Uno de los estudiantes del primer año que tenía una lesión moderada del pulmón, se comprobó que su lesión fué contrada antes de entrar en la Escuela de Medicina, desde el momento, que se descubrió en la primer radiografía, después del ingreso. El porcentaje de reacciones a la tuberculina, en alumnos del primer año, fué de 22.6 por ciento. Veinte y siete por ciento de los estudiantes que fueron

negativos al ingreso se transformaron en positivos el graduarse. El aumento en porcentaje de reacciones positivas, del primer al segundo año fué 5.9 por ciento; del segundo al tercer año fué 8.2 por ciento, y del tercer al cuatro año fué 7.2 por ciento.

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Unusual Etiology of Esophageal Perforation*

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Mediastinitis with subsequent empyema or pyopneumothorax represents one of the most common complications of esophageal perforations. However, the reverse pathogenesis, i.e. perforation of the esophagus caused by pyothorax, seems to occur with sufficient rarity as to justify the reporting of two clinical cases in which chronic empyema of non-tuberculous origin was the causative agent of the esophageal perforation.

Etiology

A brief review of the more frequent sources of esophageal perforations may be indicated here. Holinger[14] as well as McGibbon and Mather,[34] state that neoplastic disease is the most common etiologic factor of esophageal perforation. When due to malignancy it is a gradual, slow process, occurring in the far advanced stage of the disease. Clerf,[5] too, declares that cancer is the most frequent cause of ulceration of the esophagus in adults. On the other hand, according to Vinson,[49] the majority of injuries and esophageal perforations is due to foreign bodies that have been swallowed accidentally or from passage of instruments into the lumen of the esophagus.

It is generally conceded that foreign bodies are responsible for a large number of esophageal perforations, as attested by innumerable reports on this subject. It is furthermore well known that perforation of the esophagus may result from blind bougienage, gastroscopy, or even from a stomach tube (Hayes[12]), as well as from instrumentation through the esophagoscope, e.g. during the removal of foreign bodies. Biopsies of the esophagus, if taken too deep, may also produce perforations. If esophagoscopy is not performed carefully, the wall of the hypopharynx or esophagus may be traumatized or even perforated, leading to mediastinitis and death. Jackson and Jackson,[17-19] Vinson[47] and many others have emphasized the difficulties and dangers of esophagoscopy. However, during recent years fatalities from esophagoscopic examinations seem to have declined considerably. Mosher,[31] e.g. reports a

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mortality of 1.5 per cent from this procedure and after deduction of cases of cancer of the esophagus, where death resulted anyhow, his mortality was less than 1 per cent. These findings are in agreement with the observation of Schindler[43] who states: "It is usually assumed that esophagoscopy has a morbidity rate of 2 per cent and a mortality rate of 0.5 per cent. These figures would rise considerably if esophagoscopy were to be done by any other than trained experts."

Surgical perforation of the esophagus from without may also occur during tracheotomy, when the knife might penetrate the anterior esophageal wall inadvertently (Holinger,[14] Jackson and Jackson[19]).

External trauma of the esophagus is rare because of its protected position. Occasionally gunshot wounds and more rarely stab wounds have been reported (Jensen[20]). Vinson[50] described four cases of external trauma of the esophagus. One of them followed an automobile accident and postmortem examination showed rupture of the esophagus into the trachea without fracture of ribs. Aldrich and Anspach[1] published a case of rupture of the esophagus following a blow on the abdomen. Pyopneumothorax resulted and the child died within two days.

Spontaneous rupture of the esophagus is a rare occurrence. It should be differentiated from perforation of the esophagus. Rupture is caused by increased intraesophageal pressure (Ridgway and Duncan,[40] Klein and Grossman[22]), without previous sharp injury in a healthy individual (Weber[55]). Perforations, on the other hand, include punctures by foreign bodies, instrumentation, and erosion by disease.

Since the famous case of Admiral Wassenaer whose sudden illness and death was observed by the great Dutch physician Boerhaave in 1724 (cited by Barrett[2]) about 50 cases have been reported. The onset is sudden with severe vomiting, e.g. after ingestion of a heavy meal (Collis and Humphreys[6]), while moving heavy furniture (Vinson[49]), etc. The lesion is usually located a short distance above the cardia. It is nearly always fatal because of the ensuing mediastinitis. Recently Ware and Strieder,[54] on the basis of laboratory experiments, suggested early thoracotomy and suture of the laceration as rational therapy.

Spontaneous rupture of the esophagus can be confused with a perforation by the so-called peptic ulcer of the esophagus. The latter too is usually located in the lower third of the esophagus. However, the onset of ulceration is gradual, compared with the sudden spontaneous rupture. Whereas spontaneous rupture as well as perforation of the esophagus from peptic ulcer is usually

found in the lower end of the esophagus, 90 per cent of all esophageal perforations occur in the cervical region (Head[13]).

Cauterization, erosion and perforation of the esophageal wall by caustics has been described by Engler,[7] Holinger,[14] Robson,[41] and Vinson.[49]

Infected lymph glands play an important role as etiologic agents of mediastinitis and of esophageal perforation (Lerche[28]). They may erode its wall and rupture into the esophagus. Graham[11] reports a case in which a gland ruptured into the mediastinum with subsequent perforation of the esophagus and pleura.

Infected glands are usually the cause of traction diverticula. These have been defined in the classical work of Rokitansky[42] as being due to the adhesion of an inflamed bronchial lymphnode, pulling out the esophageal wall with subsequent tissue contraction. Traction diverticula, as differentiated from pulsion diverticula, are usually single, less often multiple. Pulsion diverticula, as a rule, are located at the pharyngo-esophageal junction and represent the most common type (Lahey[24]). Terry[46] states that about 98 per cent of all diverticula of the esophagus occur at this weak point. Traction diverticula are almost always found on the anterior or lateral wall of the intrapleural portion of the esophagus, at the level of the main bronchial stem and near the bifurcation of the trachea, where the lymph nodes are located. When these nodes become tuberculous, the process may involve the contiguous esophageal wall (Sturtevant, Shapiro and Wallace[45]). The great majority of traction diverticula is caused by tuberculosis. Kregh[23] states that traction diverticulum is always caused by tuberculous lymph nodes. Beverman[4] reports that 73 per cent of traction diverticula are of tuberculous origin. Traction diverticula may also be caused by adhesions between the esophagus and surrounding structures, such as thickened pleura (Clerf[5]), or by caries of the spine, non-tuberculous mediastinitis, pericarditis, cancer, or empyema (Sturtevant, Shapiro and Wallace[45]). The clinical diagnosis of a traction diverticulum is rarely made, unless rupture results (Wallace[52]).

Periesophagitis and periesophageal abscess following perforation of the esophagus, may again rupture into the lumen of the esophagus, thus healing spontaneously. Rarely an aortic aneurysm may rupture into the esophagus (Bernstein, Slater and Graysel[3]).

Tuberculosis and other chronic infections may occasionally cause perforation of the esophagus. Glynn[10] reported a case of tracheoesophageal fistula from tuberculosis proved by biopsy. Almost all tuberculous ulcerations in the esophagus follow active pulmonary tuberculosis (Clerf[5]). Exceptions are the cases of Torek[47] and Paviot (cited by Myerson[33]). In both cases no active tuberculosis

in the lungs could be found and in Paviots case there was a tracheo-esophageal fistula seen at necropsy. A few cases of esophageal perforation by a tuberculous process have been observed clinically. Recently Lawson[26] reported a case of tuberculous esophago-cutaneous fistulae, treated with streptomycin and gastrostomy. At necropsy a greater number is likely to be encountered. A case of esophago-pleural fistula caused by tuberculosis was described by Flexner.[8] A similar case was reported by Schmid.[44] Auerbach (cited by Myerson[33]) has encountered two esophago-pleural and four esophago-tracheal fistulae during a period of nine years. The former are due to penetration by an empyema and the latter by penetration of mediastinal glands (Myerson[33]).

Syphilis of the esophagus is infrequent and perforation of the esophagus from syphilis is even rarer. Engler[7] reported such a case in which clinically and at necropsy a broncho-esophageal fistula of the left bronchus could be demonstrated. A similar case, caused by actinomycosis, was seen by Vinson and Sutherland.[51]

Anatomy

In the past 25 years the topographical relations of the esophagus to the adjoining fascial planes, the surrounding spaces, and the pathways of infection into the mediastinum have been described exhaustively by such authors as Furstenberg,[9] Holinger,[14] Iglauer,[15] Lambert,[25] Lerche,[28] Lilienthal,[29] Mosher,[30] Myers,[32] Neuhof,[35] Ochsner and De Bakey,[37] Phillips,[39] Tschiassny,[48] Weintraub,[56] and others. Therefore only a few clinical aspects of the anatomical relations may be reiterated here as far as they might concern the two cases reported.

1) Acute infection in the 15 juxtapharyngeal spaces (Tschiassny[48]) did not exist in our two cases. This therefore excludes a postvisceral abscess (which would readily communicate with the mediastinum) as an etiologic possibility of mediastinitis and subsequent perforation of the esophagus.

Chronic infections in this area could not be demonstrated. In addition, peripharyngeal abscess, caused by infected lymph nodes, especially of tuberculous origin, in one of the two mural spaces formed by the buccopharyngeal fascia (Weintraubs[56] space), is usually limited at the lower border of the hypopharynx. Prevertebral abscess, from caries of the cervical spine, as a rule does not penetrate into the mediastinum. The prevertebral fascia acts usually as a barrier into the postvisceral and parapharyngeal space (Tschiassny[48]).

2) The mediastinal space is filled with areolar tissue, opposing almost no barrier to infections. This is the cause of the high mortality from mediastinitis.

3) The thoracic esophagus traverses vertically through the superior mediastinum and posterior part of the inferior mediastinum. The upper thoracic esophagus is bounded by the pleura on both sides. In the posterior mediastinum it lies between the trachea, its bifurcation and the aorta. It encroaches more on the left than on the right bronchus. In the lower middle part of the posterior mediastinum a fold of the right pleura often crosses the mid-line posteriorly. The esophagus is then surrounded by pleura on all sides (Lilienthal[29]).

4) Neuhof and Jemerin,[36] as well as Wolcott,[57] pointed out that the sub-division of the mediastinum into superior and inferior parts is artificial. There are no fascial planes forming definite compartments. The superior mediastinum should be divided for surgical-anatomical considerations into anterior and posterior spaces. The posterior division would thus represent an extension of the postvisceral cervical spaces.

5) The periesophageal lymph nodes are usually located anteriorly and laterally to the esophagus. They are most frequently found around the bifurcation of the trachea. They receive lymphatics from the lower trachea, bronchi, and lungs.

The *complications* of esophageal perforation are classified by Holinger[14] as (a) Infections, periesophagitis and abscess. (b) Hemorrhage. (c) Perforations of the pleura. (d) Emphysema. (e) Pericarditis. (f) Perforation of the trachea and bronchi. The two cases presented here show a perforation of the pleura with empyema (case 1) and perforation of the pleura and bronchus (case 2). This complication following esophageal perforation has been described by Wallfield[53] and numerous other authors. However, as the course of events started with a nontuberculous chronic empyema and produced an esophageal perforation, a discussion of the above complications is omitted here.

The *signs and symptoms* of esophageal perforation are well known. They differ according to the location of the perforation and depend upon the time-interval between the perforation and examination. Holinger[14] divides infections following esophageal perforation into two major groups: (a) Localized infection of the periesophageal tissues and (b) fulminating, extensive, septic mediastinitis. The most common symptom is severe pain and tenderness, increased with swallowing. It may be localized at the point of the perforation or between the shoulders, if the lesion is high. If the perforation is in the thoracic esophagus, the pains usually radiate to the back or to the sternum or epigastrium. Emphysema, extending into the neck, fever, rapid pulse, shock and dyspnea may follow. Perforation into specific organs (e.g. into the pleura) results in typical findings (e.g. empyema).

The *diagnosis* of perforation of the esophagus is established from the history, by physical findings and especially by esophagoscopy and x-ray studies with and without a contrast medium. Iglauer[16] mentions two cardinal x-ray signs of perforation or rupture of the esophagus. The first sign is interstitial emphysema in the periesophageal connective tissues. The second sign is the presence of a radiopaque substance outside the lumen of the esophagus, when such a substance has been administered.

McGibbon and Mather,[34] in addition to the above signs, mention forward or lateral displacement of the esophagus, widening of the mediastinal shadow in the antero-posterior view, increase in depth of the space between trachea and cervical vertebrae and passage of barium from the esophagus into the tracheo-bronchial system, if such a fistula is present. Kjellberg[21] reported recently that x-ray diagnosis of a mediastinal abscess may sometimes be aided by mediastinal puncture and injection of a contrast medium. This is best performed with a fine needle under fluoroscopic observation.

The difficulty of making an accurate diagnosis of an abscess in the posterior mediastinum is so great that many are not detected until rupture into a neighboring structure has occurred (Myers[32]).

Vinson[49] states: "When perforation has occurred, considerable study may be required to determine whether the fistula has resulted from malignant disease, foreign body or diverticulum. In the presence of mediastinal abscess resulting from diverticulum the etiologic factor cannot be determined prior to postmortem examination."

Prognosis

It is self-evident that every esophageal perforation represents a potentially serious condition because of the extensive complications that may ensue. The gravity of an esophageal perforation is depending upon the rapidity with which it occurs. Rapid, fatal sepsis results frequently. If gradual in onset, a zone of demarcation may be established with recovery. Perforation of the cervical esophagus is less grave than if the thoracic portion is involved (Graham[11]).

Treatment

Lederer[27] and his associates have recently discussed the different schools of therapeutic approach of esophageal perforations. The change in attitude since the introduction of the antibiotics was pointed out and the indications and technics for surgical procedures were enumerated. Since these authors discussed the

commonly employed therapeutic measures in detail, they are omitted here.

Case I: C.P. White male, age 49 years. In 1923 a diagnosis of pulmonary tuberculosis was made when tubercle bacilli were found in his sputum. In 1925 left phrenic exeresis was followed by an 11 rib thoracoplasty. He felt well until 1932 when out of many examinations a single positive sputum for tubercle bacilli was found. (This was the last positive sputum encountered in spite of innumerable cultures and guinea pig inoculations since that time). The patient complained of nervousness and has become an addict to opium derivatives. In November 1937 he was admitted to this hospital because of fever and development of an abscess in the axillary line of his left chest. This was incised and examined for tuberculosis by culture and guinea pig inoculations. All of them were negative for tuberculosis. A pure culture of streptococci was grown. From that time on the patient developed gradually about 10 draining sinuses all over his left chest. Some of them continued to drain off and on till December 1948. These sinuses, appearing in many different places on the left chest, were apparently not connected with each other but showed a tendency to appear gradually in higher planes. The patient denied having ever ingested a foreign body.

In December 1947 he noticed for the first time a tender red swelling on the left side of his neck, in the area of the old scar from the phrenic operation. His temperature around that time fluctuated between 101 and 102 degrees F. When this abscess was palpated by his hometown physician in February 1948, it broke through the skin in the occipital triangle. This drainage through the skin of the neck was accompanied by a gush

Figure 1

of a large amount of yellow pus from the mouth. He continued to bring up pus through his mouth for four days, while the wound in his left neck continued to drain for about six months. No smear or culture of the pus was taken during this period.

From that time on he was unable to eat any solid foods and could drink liquids only by small swallows. Since February 1946 he has received sulfanilamide and 50,000 to 200,000 units of penicillin daily, with heavier doses since February 1948. As soon as he stops penicillin, an abscess in his left chest or neck will form. While he has severe pains in his throat during eating and drinking, he never vomited or regurgitated food. Neither has he had any purulent discharge through his mouth since March 1948. He lost 28 pounds of weight within one year and entered this hospital on March 1, 1949 because of severe pains in his left shoulder.

Physical examination showed a thin poorly nourished white male, weighing 87 pounds and appearing weak. His mental status was normal. Blood pressure was 100/70, temperature 99.2 degrees F., pulse 81 and respiration 21. Chest examination showed left thoracoplasty with scoliosis of the cervical and thoracic spine. Three scars (from old draining sinuses) were seen on the skin of the left chest and one irregular scar in the occipital triangle of the left neck in the area of the old scar caused by the phrenic exeresis, performed in 1925 (Fig. 1).

Ear, nose and throat examination was essentially normal.

The x-ray films were read by our roentgenologist, Dr. Rifkin, as follows: "March 2, 1949. Flat film of chest: Almost total thoracoplasty on the left with probable pneumonectomy. Strands and small highlights in

Figure 2

the upper third of the right lung. March 11, 1949, Esophagus: Just above the clavicle is an irregularly round one inch chronic abscess cavity communicating with the esophagus by at least one opening and probably more (Fig. 2). The esophagus itself is apparently normal, as witness the normal folds. There is some slight delay, however, in its emptying time as shown by consistent and persistent filling of the valleculae. Impression: Whether this abscess began in the mediastinum and emptied itself via the esophagus, or began primarily in the latter is not clear now."

Laboratory studies: Blood, serologic examinations and urinalysis were essentially normal. Sedimentation rate was 26 mm. Sputum examination and gastric analysis were negative for tubercle bacilli. The electrocardiogram showed evidence of nonspecific myocardial damage. The Congo red test for amyloidosis showed retention of 73.3 per cent in 1 hour.

Progress in Hospital: The patient had bronchoscopic and esophagoscopic examinations under local anesthesia. Bronchoscopic findings were normal. Esophagoscopy on March 29, 1949 showed, at a distance of about 20 cm. from the upper teeth, several areas of thickened, granulomatous tissue between six and seven o'clock. The mucosa of these areas was reddened and was oozing easily when touched. A biopsy was done from this area. Smears were taken and sent to the laboratory for culture. The rest of the esophagus was normal. No actual perforation could be seen anywhere in the esophagus. The pathological report showed granulation tissue and otherwise normal esophageal mucosa. Smears and culture were negative for tubercle bacilli.

The patient was treated conservatively with 300,000 units of penicillin daily. He stated on the day following the esophagoscopy that the pains in his left shoulder had decreased considerably. Three days after esophagoscopy another x-ray inspection showed the posterior mediastinal "pocket" to appear smaller. (The first x-ray film of the esophagus was done with barium as a contrast medium. The second one was done with iodized oil, which Vinson[49] considers to be more advantageous, especially in cases of foreign bodies). He was taking liquids by mouth two days after esophagoscopy and was discharged April 1, 1949. He returned 12 days later having gained 13 pounds of weight. He stated that for the first time since February 1948 he had been able to take solid food by mouth without any pain.

Comment: There can be no doubt that this perforation was caused by the penetration of a nontuberculous chronic empyema, possibly accelerated by pressure.

The only other differential diagnostic possibilities to be considered are: (1) Erosion and rupture of infected lymph nodes into the esophagus and (2) Rupture of a traction diverticulum. As stated above, a definite diagnosis of the etiological origin of a mediastinal abscess resulting from a diverticulum can only be made at necropsy (Vinson[49]). The same is probably true in cases of rupture of a lymph node. In this case the purulent process in the chest preceded the perforation of the esophagus. Therefore, these etiologic possibilities are unlikely.

Tuberculosis as a causative agent of the perforation can be

excluded because of the following reasons: (a) The last positive sputum was found 16 years previous to the perforation in spite of numerous examinations since that time. (b) Repeated examinations of the empyema fluid showed streptococci in pure culture and guinea pig inoculations were negative for tuberculosis. (c) The infection subsided promptly after sulfanilamide and penicillin therapy. (d) Tuberculosis could not be demonstrated in the biopsy specimen from the esophagus.

The somewhat altered anatomical relations after thoracoplasty may or may not have been a factor in the causation of the perforation. At the present time a zone of demarcation seems to be firmly established around the perforation. Doubtless the spread of the disease was checked by the use of antibiotics.

The rapid improvement and ability to eat solid food after esophagoscopy may be explained by dilatation from the passage of the esophagoscope. No stricture or stenosis was seen during esophagoscopy.

The patient improved under conservative therapy. He will be observed at frequent intervals. Esophagoscopies will be repeated in an attempt to prevent the possible development of a stenosis. Appropriate treatment will be instituted as indicated.

Case II: J.M.A., 59 year old white male. This patient developed measles in September 1918 on his way to Europe. When he arrived in England, pneumonia was diagnosed. This was followed by pleurisy and empyema in his right chest. The right pleural space was drained and a rubber tube left in place. In 1931 he was hospitalized for four months in a Veterans Administration Hospital because of osteomyelitis of the sternum. The sinus in the chest and sternum both healed, but on his return home the infection in the chest again started to drain and since that time a rubber tube has been left in place permanently. The patient was admitted to this Hospital on April 18, 1949 complaining of recent weight loss, pain in the right chest and hemoptysis. He gave a history of having had pain in the left lower lateral chest for the past eight months. However, he had no complaints regarding difficulties of eating or drinking. He stated furthermore that on one occasion some time ago—he is unable to state the exact date—, a large amount of the irrigation-solution came out from his mouth, when his wife had to overcome a blocking of his drainage tube in his chest by using considerable pressure. On another single occasion, ingested methylenblue was seen by the patient to stain the dressing around the drainage tube; two more of these tests were negative.

He was fairly well nourished and developed and in no discomfort. Temperature was 98.9 degrees F., pulse 80, respiration 20, weight 164 pounds, and blood pressure 128/80.

The chest showed some atrophy and diminished expansion on the right side. There was a draining sinus in the seventh interspace in the right posterior axillary line with a tube in place. Tactile fremitus was diminished over the right lung and the percussion note was impaired over the lower half of the right side of the chest. The breath-sounds are

somewhat tubular and suppressed over the right lung. No abnormal sign was elicited over the left lung. Ear, nose and throat examination showed no significant abnormalities.

X-ray films (read by Dr. Rifkin) showed the right hemithorax to be cloudy, secondary to thickened pleura with probably some exudate. This was localized in the posterior aspects and resulted in the pulling up of the diaphragm causing the leaf to assume a plateau-like contour. The ribs showed evidence of surgical interference and there was a drainage tube in situ. On the left side there was an oval mass surrounding a partly destroyed seventh rib. On May 3, 1949 Dr. Rifkin reported the presence of a broncho-pleural-esophageal fistula on the right side when iodized oil was injected into the rubber tube under fluoroscopic observation. In addition there was a small, roughly oval shaped pocket in the right pleura posteriorly in the upper central lung field (Fig. 3).

Laboratory studies: All sputa have been negative for tubercle bacilli since admission here and were never positive before. Blood, serologic examinations and urinalysis were normal. Sedimentation rate was 26 mm. Four and one-tenth per cent of the Congo red dye for amyloidosis disappeared in one hour. On culture of the pus from the draining right chest micrococcus catarrhalis and staphylococcus albus were isolated.

On May 17, 1949 bronchoscopy and esophagoscopy were performed under local anesthesia. In the right upper lobe bronchus near its opening a small area of granulation could be observed between eight and nine o'clock with the help of the right-angle telescope. No other pathologic change was observed. Smears were taken and sent to the laboratory for culture. They were negative for tubercle bacilli. Esophagoscopy showed

Figure 3

normal findings. A thorough search did not reveal any perforation of the esophagus.

The patient had been treated with penicillin and was transferred the day following esophagoscopy for removal of the seventh rib on his left side and further observation.

Comment: Considerations similar to case I hold true here. The diagnosis of pulmonary tuberculosis could never be established in this patient. The empyema developed after pneumonia.

Unfortunately the presence of an esophageal fistula could not be demonstrated by esophagoscopy and x-ray. However, the existence of an esophago-broncho-pleural-cutaneous fistula was definitely confirmed fluoroscopically. Iodized oil was seen to enter the lower esophagus and stomach when injected through the tube draining the pleural space.

Whether the esophageal fistula was produced by pressure of the irrigation fluid (see history) could not be determined. The perforation, in all probability, was a small one. The patient had no complaints when swallowing liquids or solids and gained weight during his stay at this hospital.

SUMMARY AND CONCLUSIONS

Two clinical cases of esophageal perforation following chronic nontuberculous empyema are presented. This is a rare occurrence. Conservative therapy proved to be satisfactory. It is believed that the increased use of the antibiotics will continue to lower the frequency of nontuberculous empyemata together with the incidence of esophageal perforations from this source.

RESUMEN

Se presentan dos casos de perforación del esófago después de empiema crónico no tuberculoso. Este es un acontecimiento raro.

El tratamiento conservador demostró ser satisfactorio.

Creemos que el uso creciente de los antibióticos continuará reduciendo la frecuencia de los empiemas no tuberculosos, asi como la incidencia de la perforación por este mecanismo.

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Pulmonary Resection in Complicated Pulmonary Tuberculosis*

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Pulmonary resection now constitutes an invaluable therapeutic measure which previously was considered prohibitive due to the risks and technical difficulties which it involves. Furthermore, it has to do with human subjects affected by a pathological condition in which exeresis was contraindicated because of the danger of generalization and spreading of the lesion. Nevertheless, through perfection of technic and the aid of antibiotics, the procedure has acquired a definite place in tuberculosis therapy.

Its limitations, risks, and possible complications (spreading and reactivation of the lesions, bronchial fistulas, empyema, etc.) must be clearly recognized. On the other hand, we must agree that to a large group of pulmonary tuberculosis patients, the only remaining possibility of cure is pulmonary resection. The North American surgeons, especially the pioneers, such as Graham, Churchill, Overholt, Dolley, etc., have determined the type of case in which the operation is indicated, perfected the technic and increased the casuistics. They have shown all the benefits that can be obtained with this procedure when the operation, having been first correctly indicated, is performed by an expert surgeon under the most favorable surgical conditions. Moreover the use of antibiotics, especially streptomycin, in the anti-tuberculosis armamentarium, has increased the surgical possibilities for many patients, by either putting them in condition for the operation, or diminishing the risks of the operation.

Glover, Claggett and Hinshaw[1] reported five patients on whom they had performed pulmonary resections for tuberculosis, at the same time, administering streptomycin. The results were sufficiently encouraging to the authors to warrant proceeding with this combination of radical surgery plus antibiotics. We believe every resection must be preceded and followed by streptomycin therapy.

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In our midst, pulmonary resection for non-tuberculous diseases (bronchiectasis, suppuration, cysts, cancer), is performed frequently with excellent results (Langer[2]); not so in the cases of tuberculous lesions in which our casuistics is limited. However, one of our group published, in 1943, in collaboration with R. Finochietto and G. Sayago,[3] a case of lobectomy for tuberculosis.

The indications for pulmonary resection in tuberculosis have been clearly outlined by Overholt and his collaborators.[4-6] The observations presented in this paper merit publication in view of certain noteworthy characteristics which they present.

Case 1: June 24, 1946. A.R.S., Argentine, 26 years old, priest. Some months ago he developed periodic and frequent cough, with scant expectoration, slight pain in the left chest and hemoptysis for one month. He had 10 to 15 expectorations daily but acid-fast bacillus were not found in 10 smears. The right lung was apparently normal. X-ray inspection (Fig. 1) showed left hilar "flare" with marked emphysema of the lingulae and basal segments. *Tomography* revealed (Fig. 2) exudative nodular lesion in the left apex and *Bronchography* (Fig. 3) evidence of bronchiectasis of the lingulae and basal segment. *Bronchoscopy* showed the lumen of the left main bronchus concentrically narrowed with thickened mucosa. It was not possible to visualize the orifice of the upper lobe well. The mucosa of the bronchus of the lower lobe showed inflammatory lesions but there was no visible secretion. The electrocardiogram revealed slight right axis deviation. There was no symptom of myocardial damage.

On March 11, 1947 left pneumonectomy was performed (Dr. Langer). During the operation paroxysmal tachycardia developed, which was treated with novocaine, in the pericardial cavity. Postoperatively, the patient was in shock, with tachycardia of 180 per minute lasting several hours followed by recovery. After the operation suppuration developed in the pleural cavity with prolonged febrile state, which made it neces-

FIGURE 1: Left hilar flare and emphysema in the same side.

FIGURE 2: Tomography: Exudative nodular lesion on the left apex.

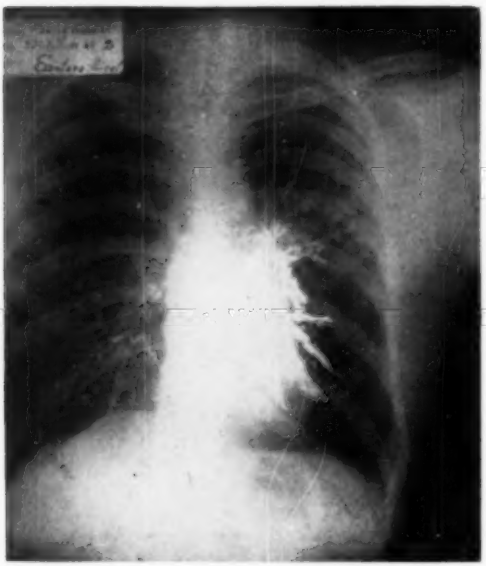

FIGURE 3: Bronchography: Bronchiectasis of the main inferior lobular bronchus and lingulae.

sary to drain thoroughly and then employ extensive thoracoplasty. The patient is now well and has returned to work (Fig. 4). Paroxysmal tachycardia was repeated with some frequency. The right axis deviation is more marked but there are no other modifications (Dr. Alzugaray).

Examination of the resected lung (Dr. Herrero) revealed (Fig. 5) pulmonary tuberculosis of the apex with stenosis of the main left bronchus, emphysema and bronchiectasis of the lingulae and basal segment. No tuberculous lesions were found in the main bronchus.

The pulmonary apical lesion, the bronchoscopic aspect, and the emphysema localized in the pulmonary segment in which the bronchi were dilated, lead us to a diagnosis of bronchiectasis secondary to tuberculous bronchial stenosis. This diagnosis forced us to perform an exeresis of the whole left lung instead of lobectomy, as would be indicated in a case of simple bronchiectasis.

Case 2: November 10, 1947. Argentine, student, 19 years old. Present illness started at 12 years of age with hemoptoic sputum. At 15 years of age, abundant hemoptysis dominating the symptomatological picture, recurring in many instances. Five months ago a series of abundant and persistent hemoptysis again occurred. There was then no cough, expectoration or fever. All sputum had been negative for acid-fast bacilli, according to the patient as well as two guinea pig inoculations. (Authoritative information could not be obtained due to the fact that her previous doctor had died).

On examination her general condition was good. Weight 69 kilos.

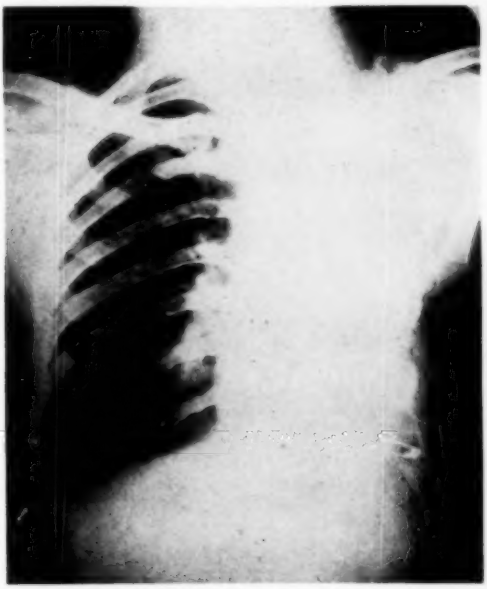

FIGURE 4: X-ray of the lung showing the patient cured.

Slight cough, yellowish-white sputum predominantly in the morning. Good appetite. Blood pressure 130/90. Sedimentation rate, November 8, 1947: 1st hour, 44 mm.; 2nd hour, 80 mm.; Katz index, 42 mm. Bleeding time, 1.15 minutes; coagulation time, 8.5 minutes. Urinalysis and blood count were normal. Reacted to tuberculin.

Physical examination of the thorax revealed rhonchi and sibilant rales in the right base and a focus of subcrepitant rales in the same region. X-ray inspection September 1942 showed increaied bronchial markings with discrete nodules in the right base. X-ray inspection in November 1947 showed nodular dissemination in the whole right lung, with those of larger size in the base. The bronchiovascular marking were increased in the left base. Bronchoscopy revealed generalized edema of the trachea with a bleeding zone in the inferior portion of the carina, which was swollen. The right main bronchus was edematous. Abundant and thick secretion was draining from the middle and inferior bronchi. The left bronchial tree appeared normal (Dr. J. Bergallo). Microscopic examination of the bronchial exudate was not contributory to the diagnosis.

Bronchography showed evidence of bronchiectasis of the basal posterior branches of the right lower lobe. The branches of the middle lobe and of the posterior segment of the superior lobe showed evidence of discrete bead-like bronchiectasis. The left bronchial tree was normal.

In view of the confirmed diagnosis of bronchiectasis a right lower lobectomy was indicated. The bronchial changes in the middle lobe and

FIGURE 5: Picture of the excised lung showing the tubercular apical lesion.

the posterior segment of the right superior, did not appear to us to be sufficiently important to justify resection of these lobes.

The miliary aspect of the right lung was not attributed to tuberculosis because of its unilateral character and the sputum continued to be negative for acid-fast bacilli. Moreover the development of the illness, recurrent hemoptysis which started at 12 years of age, without any effect on the general condition of the patient, and the lack of ulcer in the pulmonary parenchyma, which could be responsible for the hemoptysis, convinced us of the bronchial origin of the hemoptysis and of the necessity for surgical intervention as the solution of this difficult situation.

Right inferior lobectomy and crushing of the phrenic nerve was performed on December 12, 1947. Anatomicopathological examination of the resected lobe showed that its consistency was slightly augmented, and in cross-section had the aspect of a kind of miliary dissemination, sometimes confluent forming little nodules. In the basal segment of the lobe there were some dilated bronchi with thin walls full of a caseous substance. Histologically the material examined showed tuberculous follicles and intense desquamated lesions of alveolitis. The material in the bronchiectatic zone shows dilated bronchi with its characteristic cylindrical epithelium, in part ulcerated by the tuberculous lesion of the chorion, spreading into the bronchial lumen

Surrounding these bronchi were zones of atelectasis, desquamative alveolitis, acute edema and miliary dissemination to the surrounding parenchyma (Dr. Herrero). Subsequent histological study of different parts of the resected lobule showed the existence of typical follicles, many of them with giant cells of Langhans, others without them, but all with a predominance of productive tissue. The elastic pulmonary network easily visible with Weigert's stain, was nonexistent or very scant where the productive follicles were conglomerated. In many of the follicular formations it was impossible to find caseous material. In some other parts there were little nodules of larger size which also had a general productive aspect, but conglomerated follicles appeared with extensive central caseosis, in spite of which the elastic fibres are totally absent in this caseous zone. Ziehl's stain revealed acid-fast bacilli. There was a small intrapulmonary lymphatic ganglion with evident anthracosis which showed tuberculous follicles in its marginal zone.

The microscopic study of that zone where macroscopically we found bronchial dilatation showed: in the bronchial lumen, caseou spurulent exudate with acid-fast bacilli. The lumen of these dilatations were demarcated by a bronchial type epithelium with cilia. In extensive zones the epithelium and also other elements were lacking, replaced by a specific granulation tissue which presented large caseous zones. Close to this were typical productive follicles. In other parts, pneumonitis was apparent.

Anatomicopathological diagnosis: Miliary tuberculosis; bronchiectasis (Dr. J. Escarguel).

Immediately after the operation a reactivation of the pulmonary lesions in the remainder of the right lung occurred. A general dissemination with high temperature, tachycardia, and the other characteristic elements of a flare: sedimentation rate, leukocytosis, etc. On the fifth day after the operation there appeared for the first time Koch's bacilli in the sputum. (Immediately after the operation the same laboratory

technic did not reveal Koch's bacilli). Radiography of the lung also revealed extension of the lesions. On the third day after the operation, streptomycin therapy was started, 1 gm. daily for five days increasing to 1½ gm. in 24 hours until a complete dose of 200 gm. was reached. Gradually the symptoms diminished and the radiological shadows cleared. Forty-five days after the operation, when the patient had already taken 65 gm. of streptomycin, she had no fever, cough, or expectoration, and the sputum examination was negative.

The sedimentation rate had fallen to 27 mm. in the first and 55 mm. in the second hour; weight had increased to 72 kilos when the patient left the hospital to continue treatment with streptomycin and bed-rest. She was sent to a sanatorium in the mountains where she remained at the time of the writing of this paper, in perfect general condition, without fever, cough or expectoration. Her weight, 74 kilos, sedimentation rate, 16 mm. in the first and 41 mm. in the second hour.

Discussion: It is firmly established that tuberculosis can cause bronchiectasis by different pathogenic mechanisms, perhaps the most important of these being bronchial stenosis, whether produced by endobronchial lesion or by extrinsic compression. In case 2 there was no bronchial stenosis; moreover, during the operation no greater hilar alterations or lymph nodes which could be blamed for possible action upon the bronchus were found. The bronchial lesions were not limited to the inferior lobe which was resected but existed, although less severe and less extensive, in other lobes of the lung.

Is this a case of a bronchiectasis since infancy, which later became infected by tuberculosis, being a hematogenous spread and becoming worse by conditions which we cannot clarify, in the right lung (perhaps altered previously by its bronchial lesions), consequently the bronchiectasis being secondarily infected by tuberculosis? Or was it a case of tuberculosis from the beginning? Could this process be hemorrhagic diffuse tuberculous bronchitis which later underwent bronchiectatic degeneration? We do not know what tuberculosis reaction was obtained when the hemoptysis began, and we do not have good clinical records, x-rays, etc. Also, we know only through the patient and her family that her previous sputum analyses and guinea pig inoculations were negative for acid-fast bacilli. Because of the time of the beginning of the disease (at 12 years she first had hemoptysis), because of the development, of the character and intensity of hemoptysis, because of the lack of evident characteristics in her general condition, in spite of the fact that this process developed during her childhood and adolescence, we are inclined to make the diagnosis of bronchiectasis secondarily tuberculized. In addition, the miliary dissemination, which does not appear to be old, speaks in favor of this pathogenic interpretation.

Case 3: December 13, 1946. J.J., Polish business man, a resident of the country for 19 years. He gave a history of having had colds and bronchitis repeatedly. Smoked two packages of cigarettes a day; chronic cough and expectoration, which he blamed on tobacco.

In 1940 he had a severe cold with pain in the back, making him cough and expectorate worse. In 1942 he was under medical care in Buenos Aires where repeated sputum examinations were negative for acid-fast bacilli. In 1946 he entered a sanatorium for tuberculosis in Cordoba because of broncho-pulmonary symptomatology. On clinical examinations when he entered the sanatorium in December 1946, he was in good general condition, weight 77 kilos, height 1.63 mts. Cough with mucopurulent expectoration. Physical examination of the thorax revealed diminished vocal vibration with some dullness in the lower half of the left hemithorax and diminished respiratory sounds in this region. He reacted to tuberculin. Sedimentation rate (Katz index): 86.75. Direct homogenized examination and guinea pig inoculation were negative for tubercle bacilli. X-ray inspection of the lung upon entering the sanatorium showed a dense shadow in the lower half of the hemithorax with light opacity in the rest of the lung. There was exaggerated transparency in the left apex and displacement of the mediastinum to the left.

On January 10, 1947 the patient developed high temperature and empyema was detected. By thoracentesis, 200 cc. of pus was obtained. After the extraction of the pus, 2 cc. of methylene blue solution was left in the pleural cavity, which the patient expectorated the next morning. Eight days later the same procedure was performed when 100 cc. of purulent fluid was obtained, leaving in the pleural cavity 300,000 units of penicillin. Bacteriological examination of the pus was negative. A total of 2,200,000 units of penicillin was given intramuscularly. The empyema was completely controlled.

Bronchoscopy revealed a normal trachea, normal right bronchial tree, carina shifted to the left with a deep red coloration of the mucosa. There was progressive narrowing of the left bronchus caused by an extrinsic pressure reducing the lumen to a crack at the level of the upper bronchus (Dr. J. Bergallo). Tomography showed, at the 13 ctm. level, a narrowing of the main left bronchus. By bronchography there was evidence of narrowing of the left main bronchus, and bronchiectasis of the left lower lobe was seen. The bronchus of the upper lobe was rotated downward, ending in a funnel-shaped form a few millimeters from its origin, and a notch could be seen beneath the bronchus having a superior convexity, making the lumen even more narrow. It was thought that the bronchial stenosis could be the result of an old bronchial compression by possible tuberculous adenopathy. Because of the bronchial stenosis and secondary bronchiectasis with pneumonitis and empyema, a total pneumonectomy was performed on February 15, 1948 and the patient was sent home completely recovered in a short time.

During the operation it was found that the lung was completely adhered to the thoracic wall. The pulmonary tissue showed increased density. The upper lobe was much reduced in size with the lower lobe occupying nearly the entire hemithorax. In the pulmonary hilum, as in the lobar hili, there were lymph nodules, some hypertrophic some calcified and intensely adhered to the bronchial vascular tissue which made the operation difficult.

Anatomopathological examination revealed intense pleuritis. Generalized conjunctival reaction in bronchi and pulmonary tissue, particularly

at the level of the superior lobe. The bronchus of the superior lobe with walls 3 mm. thick, with a much narrowed lumen, ending in a sac-like shape about 2 cm. from its origin. Close to the bronchus and in intimate contact with it were lymph nodes so closely attached that the capsule formed one tissue with the bronchial wall. The lymph nodes had a capsule of 3 mm. in thickness. In the upper lobe there was a parenchymatous nodule of 4 mm. diameter, round-shaped and covered by a thick capsule. This was a calcified nodule closely adhered to the end of the superior bronchus, which, at this level was completely closed. The bronchi of the lower lobe had rigid thickened walls in the hilar portion, and in the peripheral zones were bronchi with thin walls resembling cystic cavities. Close to one of these cavities was one caseous nodule with caseification in its central portion, but well surrounded by a capsule. In some of the zones of the lower lobe could be seen small, caseous, well-encapsulated nodules.

Histological examination of the lymph node of the superior lobe showed connective tissue which contained calcium salts, having the histological characteristics of a primary lesion. The bronchus of the upper lobe was thickened because of an intense connective tissue reaction. One of the bronchi had its cartilaginous tissue ossified. The caseified nodule described, close to the bronchial dilatations, was surrounded by epithelial cells and a lymphocytic halo. No specific tuberculous lesions were found in any of the examined bronchi. The pulmonary tissue showed edematous and hemorrhagic alveolitis, large deposits of hematic pigments and abundant anthracosis. Scattered through the pulmonary tissue were small caseous foci surrounded by epithelioid cells enveloped by thick fibrous connective tissue; small abscesses, some with macropathic reaction.

Discussion: Considering the lesions we have found; calcified hilar lymph nodes compressing the main lobar bronchi, the parenchymatous calcified nodule, the intense conjunctival bronchial proliferation, especially in the bronchus of the upper lobe (adjoining the parenchymatous nodule) the encapsuled caseous nodular lesions of the lower lobe, with bronchiectasis and cystic dilatation, it is our impression that the pathogenic mechanism of this process can be imputed to a bronchial compression produced by tuberculous adenopathy, probably due to primary infection. Secondarily, there appears the bronchopulmonary lesions that dominated the clinical picture (atelectasis, pneumonitis, bronchiectasis, empyema, etc.).

It remains to be clarified whether the intense conjunctival bronchial reaction of the upper lobe which produced its total occlusion, was caused by a primary bronchopulmonary lesion, or whether it was the result of the secondary tuberculous localization of the mucosa of the bronchus. There is enough evidence to establish a relationship between this process and a primary tuberculous infection; however, in the pulmonary parenchyma there were no lesions that can explain the bronchial alterations as produced by a reinfectious type of tuberculosis.

SUMMARY AND CONCLUSIONS

In our midst, as a rule, resection for active tuberculosis was not undertaken until one year ago. Consequently, our experience is limited. However, we feel that the three cases described merit this communication.

The first case is a young man with familial history of tuberculosis with hemoptysis of eighteen months' duration, sputum negative for acid-fast bacilli. A diagnosis of bronchiectasis in the lingulae and basal segments was made and left pneumonectomy was followed by recovery. The pathologic study revealed an active caseous tuberculosis in the apex, chronic inflammatory changes throughout the left main bronchus, and bronchiectasis.

The second case is a girl of 19 years, with a history of severe hemoptysis for the last seven years. Repeated sputum examinations were negative for acid-fast bacilli. Bronchographic study revealed cylindrical dilatation of the two right basal posterior branches. Right lower lobectomy was performed and the specimen showed miliary tuberculosis and bronchiectasis. Immediately after the operation an extensive flare up in the remaining right lung occurred. Sputum was positive for tubercle bacilli for the first time in her history. Streptomycin therapy was instituted with total clearing of the x-ray shadows, and repeated negative sputum.

The third case is a middle-aged man with a history of repeated attacks of pneumonitis with fever, cough and mucopurulent expectoration, complicated by a purulent empyema which was treated medically. Negative sputum. There was evidence of bronchiectasis in the left lower lobe and complete stenosis of the bronchus of the upper lobe. Left pneumonectomy was performed followed by uneventful recovery. The specimen showed a primary calcified lymph node in intimate relation with the notch of the upper lobe and main bronchus. The upper lobe bronchus, almost totally occluded by hypertrophic changes of the mucous membrane; bronchiectasis and caseous nodules in the lower lobe.

RESUMEN Y CONCLUSIONES

En nuestro medio la resección por tuberculosis activa no se ha emprendido sino hasta hace un año. Por ese motivo nuestra experiencia no es muy extensa pero creemos que tres casos merecen que se comuniquen.

El primer caso es de un joven con antecedentes de tuberculosis en su familia, hemoptisis de dieciocho meses de duración, esputo negativo. Se hizo diagnóstico de bronquiectasia de la língula y de segmentos basales. Se realizó neumonectomía izquierda con recuperación. El estudio histopatológico demostró que existía una tuber-

culosis activa caseosa del vértice, inflamación crónica del bronquio principal izquierdo y bronquiectasis.

El segundo caso de una joven de 19 años con severas hemoptisis durante los últimos siete años. Esputos constantemente negativos al bacilo tuberculoso. Broncografía: dilataciones cilíndricas de las dos ramas basales posteriores derechas. Se hizo lobectomía inferior derecha y el especimen demostró tuberculosis miliar y bronquiectasis. Inmediatamente después de la operación se presentó exacerbación en el pulmón derecho. El esputo resultó positivo por primera vez en su historia. Se trató con estreptomicina con completa desaparación de las sombras patologicas o la radiografía y negativación persistente de los esputos.

El tercer caso es de un hombre en la edad media de la vida con antecedentes de reiterados ataques de neumonitis febril con tos y expectoración mucopurulenta complicado con empiema tratado médicamente. Esputo negativo. El broncograma demostró bronquiectasis del lóbulo inferior izquierdo y estenosis completa del bronquio del lóbulo superior. Se hizo neumonectomía con recuperación completa. El especimen demostró ganglio primario calcificado en relación con el tronco del bronquio principal y lóbulo superior. El bronquio del lóbulo superior casi completamente ocluído por cambios hipertróficos de la mucosa. Bronquiectasis y nódulos caseosos en el lóbulo inferior.

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Discussion

JAMES D. MURPHY, M.D., F.C.C.P.
Oteen, North Carolina

It is to be regretted that the illustrative material that was to have accompanied this very interesting presentation by Dr. Pérez did not arrive. These reports have been heard with a great deal of interest for several reasons; primarily because they indicate that our fellow surgeons in South America are thinking along the same lines as we are in the therapy of tuberculosis; secondly, it indicates that in an organization such as ours, which is international in scope, papers can be presented by members of this and other nationalities on scientific subjects which are concerned only with the welfare of the patient in contradistinction to those international gatherings of a political nature wherein national policies are preeminent.

Pulmonary resection for tuberculosis is a controversial subject. Since the early animal experiments by Gluck, Bloch and others, from 1881 to 1883, the possibility of extirpation of a diseased focus by one operation has appealed to the surgical mind. Interest in this field has increased since 1933 when Graham, Lilienthal and several others almost simultaneously reported successful pulmonary resections. Nevertheless, the American Literature up to 1944 has recorded only approximately 90 cases of pulmonary resection for tuberculosis. In a recent review of the literature (slides) up to May 1948, we were able to find 616 reported resections for tuberculosis. There was an overall mortality rate of 26 per cent, and an immediate operative mortality of 15 per cent. In 456 of these 616 cases it was possible to determine the percentage of pulmonary spreads or exacerbations following resections; 26 per cent of these patients developed contralateral spread or exacerbation. Again, in a total of 421 of these patients, it was possible to determine that empyema developed in 12 per cent, bronchopleural fistula in 6 per cent following operation.

Our own experience prior to the advent of streptomycin was limited to 11 resections. All were done for residual post-thoracoplasty cavities. In this series there was 18 per cent of early deaths, 18 per cent of late deaths, 55 per cent empyematous, 55 per cent fistulas, 27 per cent exacerbations and a negative sputum was obtained in 55 per cent. That was a discouraging picture. At this time, however, two other factors entered into the picture through which we were able to completely reverse this unhappy situation. The first factor was the use of the Overholt position. By means of a modification of the Albee-Compere orthopedic table we were

able to quickly and cheaply convert our equipment to this position. By means of this position contralateral spread is diminished, and when one adapts himself to its use the operation is easier. One very desirable feature from the surgical standpoint is that the surgeon may sit down during a substantial part of these long operations. The second factor was the use of streptomycin. In January 1947, we became a part of a cooperative study being conducted by the Veterans Administration, the Army and the Navy to determine the bacteriostatic effect of streptomycin on the prevention of spreads, empyemata and fistulae following thoracic surgical operation. From January 1947 to October 1947 daily doses of 1.8 gram of streptomycin, divided into six doses of 0.3 gram each was administrated for one week preoperatively and two weeks postoperatively in every resection. On October 15, 1947 this dosage was reduced to one gram divided into two doses daily. This reduction was made because concomitant studies on the effects of streptomycin on pulmonary tuberculosis had revealed that a substantial percentage of patients became resistant to streptomycin and that symptoms of toxicity manifested by vertigo and ataxia developed in a large number of patients after six weeks of administration.

Since January 1947, we have done 74 resections using streptomycin as a prophylactic agent in spreads, empyemata and fistulae. Indications for which we have performed these operations are: (1) residual cavity after thoracoplasty, 38 cases; 35 per cent of these had endobronchial disease; (2) failure of more conservative methods of collapse therapy, 13 cases; endobronchial disease was present in 5 of these and hilar or basal cavity in 5. Tuberculous bronchiectasis, 13 cases. Destroyed lung, 10 cases. As an elective procedure, 7 cases. Severe endobronchial disease three cases, and tuberculoma, one case. Forty per cent of all cases showed endobronchial tuberculosis. In view of the established safety of pulmonary resection, using modern surgical technic, with streptomycin, and adequate blood replacement, there can be little quarrel with any of these indications except that of the elective procedure. The low mortality and favorable early results in our series is shown by comparing the operations done in the prestreptomycin era with those following the use of streptomycin.

Early deaths have been reduced from 18 per cent to 8.1 per cent.
Late deaths have been reduced from 18 per cent to zero.
Empyemata have been reduced from 55 per cent to five per cent.
Fistulae have been reduced from 55 per cent to five per cent.
Spreads have been reduced from 27 per cent to four per cent.
Sputum conversion has been increased from 55 per cent to 92 per cent of the living patients.

In 25 per cent of our cases the cavity was entered during dissection, but one case of empyema developed. We have been unable consistently to accomplish these dissections without contaminating the pleura in a certain number. The cases that developed empyema were those following bronchopleural fistula, and it is thought that with improved surgical technic this can be largely eliminated. We are satisfied that with streptomycin and modern operating technique pulmonary resection can be done safely and with excellent early results. If the late results bear out this early trend, the therapy of tuberculosis must be revolutionized. It will then be a question of improving our diagnostic acumen to a point where we can fortell with reasonable accuracy which early lesion or cavity can be controlled with simple measures and those which might resist pneumothorax and thoracoplasty. If those resistant lesions can be excised, early, possibly a segmental resection can be done and the patient saved many years of hospitalization and therapy.

RICHARD MEADE, M.D., F.C.C.P.
Grand Rapids, Michigan

For me to carry on this discussion in place of other men who have had such vast experience is rather absurd, if I should talk to you only of my personal experience. I have had occasion, though, in the last two years to review the work of Overholt and Maier and Sweet and others whose work you have seen presented on the slides, and have come to feel that there is no question whatsoever but that resection is now an accepted method of treatment. As Dr. Murphy has said, if one could know in advance which lesions were going to heal without surgery, which would respond to collapse therapy, we could go ahead with resection and could have vastly improved results; and that, of course, would be an ideal situation. The question I think no longer exists in regard to resection for certain definite indications, and those have been presented to you. I think there still exists, however, the question of elective resection; that is, should we do a resection in cases in which collapse therapy may accomplish the same results. That is now not quite so simple as it was two years ago because most of the men doing resections today feel that resection should be followed by thoracoplasty. We have, then, the choice between collapse measures of a permanent nature such as thoracoplasty, and resection followed by thoracoplasty. If we could tell whether or not the cavities that are closed by collapse measures will remain closed and not again give trouble, there would seem to be no reason for

subjecting the patient to a supplementary operation such as resection. There is however, evidence that these cavities that are closed so far as x-ray shows, following thoracoplasty, do not as a rule result in scar formation but are closed caseous areas which may later break down and give trouble. If we could be sure of that there could no longer be any question that when you have a choice of doing resection or collapse, a resection would be better. I am looking forward to hearing further discussion on this subject from Dr. Overholt and others who have had such great experience.

RICHARD H. OVERHOLT, M.D., F.C.C.P.
Brookline, Massachusetts

What we have heard this morning is further evidence of the soundness of the original concept that some of the complicated forms of tuberculosis might best be treated by surgical removal. I think we are very fortunate to have Dr. Pérez bring us his experience from Argentina and also to have Dr. Murphy and Dr. Meade summarize the work of various clinics in this country.

This year Dr. Meade is Chairman of the Committee on Surgical Treatment of the Trudeau Society and recently those serving on the committee, Dr. Maier, Dr. Sweet, and myself met to study reports on resection for tuberculosis returned from many surgeons of this country and Canada. It was rather interesting to find that almost everyone is coming to see eye to eye on this problem.

Indications are becoming more crystal clear. We all wish to select that form of treatment which will give permanently good results in the simplest and safest way. Admittedly, there is always room for honest differences in opinion when it comes to prognosis and percentage chances of success with one form of treatment or the other.

(Slides) Recently, Dr. Norman J. Wilson has looked over our own results in something over 300 cases. It seems to us that all patients can be placed in two principal groups when speaking of indications: Group A: For those in whom a good thoracoplasty has failed, and Group B: For those in whom a thoracoplasty would most likely fail. Now in this second category of predicted thoracoplasty failure, it is possible to break them down into five sub-groups.

1) Patients having associated bronchiectasis that is giving symptoms or is affecting recovery.

2) Those having extensive disease of the lower lobe who can in many instances be most decisively treated by resection.

3) Patients suffering from parenchymal disease complicated by stenosis which interfers with bronchial drainage.

4) For extensive unilateral disease where lesions are of such a character or are so situated that a good thoracoplasty would likely fail.

5) In the last sub-group that should be included are those cases of tuberculoma of size. For some of these we have limited the resection to the pulmonary segment if the disease has been found to be so limited.

Of course, the difficulty in appraising results and the risk of operation comes when we try to group together all of the patients the conscientious surgeon tries to help. We all see desperately ill cases and if there is a reasonable chance of saving their lives we should give them that chance, regardless of statistics. The antibiotic drugs have been of tremendous value and techniques are being constantly improved. The sharp reduction in complications will greatly influence the later results.

Editorial

CHEST X-RAY SURVEYS AND TUBERCULOSIS

The percentage of abnormal findings seen in mass chest x-ray surveys has been somewhat uniform in various cities regardless of tuberculosis mortality rates. This has resulted in considerable discussion and even questioning of the procedure by physicians who had anticipated the largest yields of clinical cases where the present mortality rates are highest. This relatively uniform finding is not surprising when the following determining elements are considered.

1) Persons who respond to a chest x-ray survey are, for the most part, in good general health. From the same community, most of those who have become ill from tuberculosis are already in sanatoriums, and hospitals, have changed climate (moved to their former homes, etc.) or are in their homes and do not participate in the survey. Many of those who are convalescing or have recovered are under the care of physicians and see no personal advantage in the survey. Directors and workers in surveys often place emphasis on the high percentage of persons with shadows detected who are not on record with the health department. This is not surprising because the majority of those already on record may not respond to the survey.

2) Persons who know that they have tuberculosis which has not been reported and others who have reason to suspect the presence of this disease are prone to avoid health authorities. Such individuals usually do not respond to voluntary surveys regardless of where they live.

3) If the infection attack rate is high in a community there are apparently well persons who have had exudative pulmonary foci which have receded so as to cast no x-ray shadow. This may be a considerable number. On the other hand, many persons with the exudative type of tuberculosis have symptoms appear early in the course of the disease and are promptly removed from the general population for treatment. A sizeable percentage of these persons died in the past regardless of how or where they were treated. It is well known that bronchogenic spread of tubercle bacilli may result in the appearance of advanced disease in a matter of days or weeks after an x-ray film of the chest appears clear. Such persons have a short sojourn in the community before the disease is diagnosed and treatment is instituted. Many of them die. Wherever large numbers have primary tuberculosis (tuberculous infection), acute highly fatal conditions such as miliary disease and meningitis increase the mortality rate.

4) Where good tuberculosis control measures have not been

operating long, there has been daily seeding of parts of the population with tubercle bacilli. This is unlike seasonal seeding with the harvesting of a crop at a fixed time. Moreover, when tubercle bacilli are planted in human tissues among those who develop clinical disease, the maturity of lesions varies tremendously—from months to decades. Therefore, one cannot expect that a high percentage of clinical lesions will be in evidence at any given time. This characteristic of tuberculosis has long misled physicians as evidenced by statements to the effect that only 1 or 2 per cent of infected persons become clinical cases. These statements are based on cross-section studies which never reveal the true picture of such a vicissitudinous disease as tuberculosis. It is only through longitudinal studies consisting of periodic examinations for many years or decades of the infected that one perceives the actual situation. Such studies have revealed that in no single year does a large percentage of infected persons present evidence of clinical lesions. However, enough new ones appear from time to time to make the aggregate alarming over a period of 25 years or longer. Thus, over the years some lesions recede and disappear, while others advance, cause symptoms, are diagnosed and their hosts are removed to institutions or they die, so that at no given time is a large number of demonstrable lesions present among apparently healthy persons.

Mortality rates are influenced by the accruement of chronic cases who are in and out of institutions over years but have long since been diagnosed. It is well known that in the past, among persons with moderately and far-advanced disease, from 70 to 80 per cent were dead within 10 years regardless of treatment. Although old chronic cases continue to die, the young adults of the community may have been well protected since birth and demonstrable lesions are so rare among them as to influence the total number of shadows found in a survey.

5) The medical profession of large areas of the United States has become exceedingly alert and active in the diagnosis of tuberculosis. It is amazing how many physicians are using the tuberculin test, making x-ray inspections of the chests of adult reactors, not only once, but periodically, and completing the examinations for all whose films reveal abnormal shadows. Thus in many places they are keeping the population reasonably well depleted of unsuspected cases of clinically significant tuberculosis. The ultimate goal will be attained when physicians everywhere assume the responsibility for tuberculosis control in their respective communities. Until this occurs mass chest x-ray surveys can play such an important role in our cities as to deserve full support of the medical profession. J.A.M.

Sixteenth Annual Meeting of the College

SAINT FRANCIS HOTEL, SAN FRANCISCO, CALIFORNIA

JUNE 22 THROUGH JUNE 25, 1950

PRELIMINARY PROGRAM

FRIDAY, JUNE 23rd, MORNING SESSION:

"Streptomycin and Artificial Pneumoperitoneum in Pulmonary Tuberculosis,"
Benjamin L. Brock, Downey, Illinois.
Discussion by Andrew L. Banyai, Milwaukee, Wisconsin.

"The Comparative Morphology of the Tubercle Bacillus."
Emil Bogen, Olive View, California.
Discussion by Henry C. Sweany, Chicago, Illinois.

"Clinical Results and Physiologic Effects of Immobilizing Lung Chamber Therapy in Patients with Pulmonary Tuberculosis,"
Alvan L. Barach, New York, New York.
Discussion by G. L. Bellis, Winnebago, Wisconsin.

"The PAS Salt of Streptomycin,"
Edward Dunner, Livermore, California.
Discussion by William S. Klein, Spivak, Colorado.

"The Present Status of Antibiotic Treatment of Pulmonary Tuberculosis,"
H. Corwin Hinshaw, San Francisco, California.
Discussion by John Barnwell, Washington, D. C.

Afternoon Session:

"Clinical Evaluation of Cytologic Studies in the Diagnosis of Carcinoma of the Lung,"
Seymour M. Farber, San Francisco, California.
Discussion by Alton Ochsner, New Orleans, Louisiana.

"The Role of Bronchoscopy in the Diagnosis and Treatment of Bronchial Adenoma,"
Chevalier L. Jackson, Philadelphia, Pennsylvania.
Discussion by Paul H. Holinger, Chicago, Illinois.

"The Use of Antibiotics in the Treatment of Pulmonary Emphysema,"
Edwin R. Levine, Chicago, Illinois.
Discussion by Burgess Gordon, Philadelphia, Pennsylvania.

"Reversible Forms of Heart Disease,"
John F. Briggs, St. Paul, Minnesota.
Discussion by Arlie R. Barnes, Rochester, Minnesota.

"Tuberculosis Control in Institutions for the Mentally Ill,"
Edmund W. Miller, Anoka, Minnesota.
Discussion by Jay Arthur Myers, Minneapolis, Minnesota.

SATURDAY, JUNE 24th, MORNING SESSION:

"Bronchial Lavage in the Treatment of Pulmonary Tuberculosis,"
Manoel de Abreu, Rio de Janeiro, Brazil.

Discussion by Harold G. Trimble, Oakland, California.

"Diagnosis of Fungus Disease of the Chest,"
Maxwell L. Littman, New Orleans, Louisiana.

Discussion by Arthur W. Duryea, Alexandria, Louisiana.

SUNDAY, JUNE 25th, MORNING SESSION:

"Oleothorax Following Pulmonary Resection,"
Neil C. Andrews, Douglas R. Morton, George M. Curtis and Karl P. Klassen, Columbus, Ohio.

"Auricular Appendectomy in the Treatment of Multiple Peripheral Emboli,"
William D. Longmire, Los Angeles, California.

"Complications Following Pulmonary Resection,"
James B. Murphy, Harry E. Walkup and Hawley H. Seiler, Oteen, North Carolina.

"Exploration of Coin Lesions,"
S. W. Harrington, Rochester, Minnesota.

Discussion by Paul C. Samson, Oakland, California.

Afternoon Session:

"Present Status of Resection in Treatment of Pulmonary Tuberculosis,"
Richard H. Overholt, Norman J. Wilson and Francis M. Woods, Brookline, Massachusetts.

Discussion by John B. Grow, Denver, Colorado.

"Bronchiogenic Carcinoma Masquerading as Other Diseases of the Chest,"
J. Karl Poppe, Portland, Oregon.

Discussion by Ephraim Korol, Downey, Illinois.

"Considerations of the Clinical and Physiologic Factors in the Treatment of Chronic Pulmonary Conditions,"
Burgess Gordon, Philadelphia, Pennsylvania.

"Cardio-Respiratory Studies in Pre and Post Operative Funnel Chest (Pectus Excavatum),"
A. Lincoln Brown, San Francisco, California.

"Indications and Contra-Indications for Use of Decortication Procedures in Tuberculous Patients,"
Osler A. Abbott, Emory University, Georgia.

ROUND TABLE LUNCHEONS

FRIDAY, JUNE 23rd:

"Bronchial Asthma,"
Leon Unger and Albert H. Andrews, Chicago, Illinois.

ROUND TABLE LUNCHEONS (Continued)

"The Management of Tuberculosis in the Older Age Group,"
A. Worth Hobby, Atlanta, Georgia and
Foster Murray, Brooklyn, New York.

"Air Contamination,"
Moderator to be announced.

"Suppurative Diseases of the Lung,"
Coleman Rabin, New York, New York.

"BCG Vaccination,"
Moderators to be announced.

"Evaluation of Pulmonary Function,"
George G. Ornstein, New York, New York.

SATURDAY, JUNE 24th:

"Management of Cavitary Tuberculosis in Young People,"
Donato G. Alarcon, Mexico City, Mexico and
David Ulmar, New York, New York.

"Dust Diseases,"
Moderator to be announced.

"Use and Dosage of Newer Antibiotics and Chemicals in Tuberculosis,"
Karl Pfuetze, Cannon Falls, Minnesota, Arnold Shamaskin, Hines, Illinois and Emil Bogen, Olive View, California.

"Home Management of Tuberculosis,"
Clarence Payne, Chicago, Illinois and Eli Rubin, Bronx, New York.

"Pneumoperitoneum,"
Andrew L. Banyai, Milwaukee, Wisconsin and
Harold G. Trimble, Oakland, California.

"The Value of Antihistaminics in the Common Cold,"
Fred W. Wittich, Minneapolis, Minnesota and
Frank R. Ferlaino, New York, New York.

SUNDAY, JUNE 25th:

"Fungus Diseases of the Chest,"
Moderators to be announced.

"Emphysema,"
Alvan L. Barach, New York, New York.

"When Should Pneumothorax be Terminated,"
Moderators to be announced.

"Bronchiectasis and Bronchitis,"
Paul C. Samson, Oakland, California and
Louis L. Friedman, Birmingham, Alabama.

"Use and Dosage of Newer Antibiotics in Non-Tuberculous Diseases,"
Wallace E. Herrell, Rochester, Minnesota.

"Evaluation of the Cardiac Status of Patients,"
Italo Volini, Chicago, Illinois.

X-RAY CONFERENCE

The Annual X-Ray Conference to be held on Saturday afternoon, June 24, will be presided over by Dr. Leo G. Rigler of Minneapolis, Minnesota. Physicians who plan to attend the meeting are invited to submit interesting or unusual proved cases for demonstration and discussion. Films must be of good quality and the examination complete. Please send your films, together with clinical abstract and laboratory findings of the case, to Dr. Leo G. Rigler, University of Minnesota Hospitals, Minneapolis 14, Minnesota, for consideration.

MOTION PICTURE SESSION

A motion picture session on diseases of the chest will be presented on Friday evening, June 23. Dr. Paul H. Holinger of Chicago is in charge of this session. If you have a film which you would like to present at the meeting kindly send title and description of film, the size of the film, whether silent or sound, color or black and white, to Dr. Paul H. Holinger, 700 North Michigan Avenue, Chicago, Illinois.

HOTEL RESERVATIONS

Reservations for the annual meetings of the American College of Chest Physicians and the American Medical Association must be made through the AMA HOTEL COMMITTEE, ROOM 200, 61 GROVE STREET, SAN FRANCISCO 2, CALIFORNIA.

To be certain you will have a hotel room, we urge you to make your reservations for the meetings at once, using the official application form which appears in the Journal of the American Medical Association. Copies of this application may be obtained from the AMA Hotel Committee.

It is advisable that you mention you are going to attend the meeting of the American College of Chest Physicians so that you may be assigned to a hotel as close as possible to the College headquarters. Be sure to specify arrival and departure dates.

PRIZE ESSAY AWARD

The Board of Regents of the American College of Chest Physicians offers a cash prize award of two-hundred-and-fifty dollars ($250.00) to be given annually for the best original contribution, preferably by a young investigator, on any phase relating to chest disease.

The prize is open to contestants of foreign countries as well as those residing in the United States. The winning contribution will be selected by a board of impartial judges and the first award will be made at the forthcoming annual meeting of the College to be held in San Francisco, June 22-25, 1950.

The College reserves the right to invite the winner to present his contribution at the annual meeting, and to publish the essay in its official publication "Diseases of the Chest." Contestants are advised to study the format of "Diseases of the Chest" as to the length, form and arrangement of illustrations to guide them in the preparation of the manuscript.

The following conditions must be observed:

(1) Five copies of the manuscript, typewritten in English, should be submitted to the office of the American College of Chest Physicians not later than May 1st, 1950.

(2) The only means of identification of the author or authors shall be a motto or other device on the title page and a sealed envelope, bearing the same motto on the outside, enclosing the name of the author or authors.

Additional information may be obtained from the Executive Secretary of the College, 500 North Dearborn Street, Chicago 10, Illinois.

Committee on Prize Essay

Eli H. Rubin, M.D., New York City, Chairman
Charles P. Bailey, M.D., Philadelphia, Pa.
Hugh L. Houston, M.D., Murray, Kentucky
David Salkin, M.D., San Fernando, California
Henry C. Sweany, M.D., Chicago, Illinois.

POSTGRADUATE COURSES TO BE PRESENTED BY AMERICAN COLLEGE OF PHYSICIANS

Electrocardiography: Basic Principles and Interpretation,
Boston, Massachusetts, May 8-13.
Endocrinology,
Chicago, Illinois, May 15-20.
The Dynamics of Metabolic Diseases,
New York, New York, May 15-20.
Trends and Newer Developments in Internal Medicine,
Philadelphia, Pennsylvania, June 5-10.
Internal Medicine,
San Francisco, California, June 19-23.
Clinical Aspects of Malnutrition,
Mexico City, Mexico, August 14-26.

College Chapter News

CUBAN CHAPTER

The Cuban Chapter of the College held a special meeting on March 8 in honor of the visit to Havana of Dr. Louis Mark, Columbus, Ohio, President-Elect of the College. The meeting was held at the Hospital Curie at which time the following program was presented:

"Neumonectomia por Cancer del Pulmon,"
E. Torroella, M.D. and Antonio Navarrete, M.D.

"El Factor Obstructivo Bronquial en la Tuberculosis Primaria del Niño,"
J. Rouco, M.D. and Teodosio Valledor, M.D.

"Tuberculosis Pulmonary Basal de Evolucion Atipica con Hemoptisis Grave, Tratada por Lobectomia,"
R. Ballestero, M.D. and H. Anido, M.D.

"Tumores del Mediastino,"
A. Guiral, M.D.

The officers of the Cuban Chapter gave Dr. Mark a farewell dinner which was also attended by Dr. Edgar Mayer of New York City, who was visiting in Havana at the time.

ILLINOIS CHAPTER

The Illinois Chapter held a joint meeting with the Chicago Tuberculosis Society on March 10 at the Congress Hotel, Chicago. The following program was presented:

"Interauricular Septal Defect with Pulmonary Hypertension, Case Demonstrations,"
Oldrich Prec, M.D., Ph.D., Cardiophysiologist,
Raoul Casas, M.D., Research Fellow and
William Mavrelis, M.D., Pathologist,
Cardiovascular Research Laboratory of Hektoen Institute, Children's Division, Cook County Hospital and Department of Pathology, Cook County Hospital.

"Newer Aspects of Diagnosis and Surgical Management of Cardiovascular Anomalies,"
Willis J. Potts, M.D. and Stanley Gibson, M.D., Chicago.

TEXAS CHAPTER

The Texas Chapter of the College will hold its annual meeting at the Texas Hotel, Fort Worth, on May 1st, in conjunction with the meeting of the State Medical Association of Texas, May 2-3. The following program will be presented at the chapter meeting:

Morning Session:

SYMPOSIUM ON EXTRAPULMONARY TUBERCULOSIS

"Ophthalmological Manifestations of Tuberculosis,"
Maxwell Thomas, M.D., Dallas.

"Dermatological Manifestations of Tuberculosis,"
Duncan C. Poth, M.D., San Antonio.

"Treatment of Active Tuberculosis in Infants and Young Children,"
George Brown, M.D., Dallas.

"Tuberculosis of the Female Genital Tract,"
William F. Guerriero, M.D., Dallas.

"Tuberculosis of Bone—Orthopedic Surgery,"
P. M. Girard, M.D., Dallas.

"Tuberculosis of the Liver,"
H. A. Topper, M.D., Dallas.

Discussion.

Afternoon Session:

"Recognition, Physiology and Management of Cor-Pulmonale,"
W. W. Bondurant Jr., M.D., San Antonio.

"Pulmonary Manifestations of Systemic Diseases,"
John M. Middleton, M.D., Galveston.

"Pneumonias of Non-Pneumococcal Origin,"
Elias Strauss, M.D., Dallas.

"Arthritis and Fibrositis in Relation to Pulmonary Disorders,"
M. D. Levy Jr., M.D., Houston.

"Clinical Pathological Conference,"
Charles T. Ashworth, M.D., Fort Worth.

Annual Business Meeting.

Election of Officers.

Evening Session:

Dinner Meeting.
Jesse B. White, M.D., F.C.C.P., Amarillo, President, Texas Chapter, American College of Chest Physicians, presiding.

Guest Speaker: Charles T. Stone, M.D., Galveston.

VIRGINIA CHAPTER

The Virginia Chapter of the College held their spring meeting on March 30th at the University of Virginia in Charlottesville. Dr. E. C. Drash, President of the chapter, presided.

College News Notes

Dr. Albert H. Andrews Jr., Chicago, addressed the Chicago Laryngological and Otological Society at a meeting on March 5 at the Drake Hotel, Chicago. His subject was "Correlation of the Papanicoloau and Biopsy Methods in the Diagnosis of Laryngeal, Bronchial and Esophageal Tumors."

Dr. Louis Cohen, Philadelphia, has been named clinical professor of medicine at Temple University Medical School to succeed his brother, Dr. A. J. Cohen, who died December 30.

Dr. Evarts A. Graham, St. Louis, Missouri, addressed the Jackson Park Branch, Chicago Medical Society, on March 16, on the subject "Some Newer Concepts Concerning Bronchogenic Carcinoma."

Dr. Brian Blades, Washington, D. C., will present a paper entitled "Rehabilitation in Chest Surgery," at the meeting of the Eastern Section of the American Congress of Physical Medicine to be held in Washington on April 29.

Dr. Edgar C. Harper, tuberculosis control officer at the Veterans Hospital, Richmond, Virginia, has been transferred to the hospital at Mountain Home, Tennessee as chief of tuberculosis service and tuberculosis control officer.

Dr. Glen W. Doolen, Chief, Tuberculosis Section of the Washington, D. C. Area Medical Office, Veterans Administration, has become manager of the Memphis, Tennessee Veterans Hospital, succeeding Dr. Franklin C. Cassidy, who is being transferred to San Francisco, California.

Philadelphia has been gathering the facts about its tuberculosis problem as the first step toward better control of the disease in the city. A series of articles beginning in the current issue of Public Health Reports, a publication of the Public Health Service, Federal Security Agency, describes the findings of a team of researchers—a doctor, a nurse, and a social worker—who were asked by the city to dig out the facts about tuberculosis in Philadelphia. In a lead editorial, Dr. Robert J. Anderson, Chief, Division of Tuberculosis, Public Health Service, praises the "courage and farsightedness" of the official and voluntary agencies of Philadelphia which backed the investigation. "They are making a contribution not only to their own community," Dr. Anderson's editorial declares, "but also to other areas with a similar complex of health and social agencies and similar problems in tuberculosis control."

Obituaries

STEPHEN KING MONTGOMERY

1895-1950

It is my sorrowful duty to record the death, in Cape Town, on the 20th of January 1950, of Dr. S. K. Montgomery, who was a member of the South African Chapter (Southern) of our College.

Born in Tasmania in 1895, he soon moved with his family to New Zealand, from whence, during his early boyhood, they returned to Perth in Western Australia where he graduated B.A. with honors in the Perth University. The First Great War interrupted his studies, which he resumed after military service, graduating B.Sc. with honors in Zoology. For his medical studies he proceeded to London, where, after an active student life at the University College Hospital, he graduated M.B., B.S., London in 1926. Interneships at the University College Hospital, the Hospitals for Tropical Diseases in London and Newcastle, and the British Hospital, Port Said followed, and on his return to London he took his M.D. Choosing radiology as a specialty, he proceeded to Edinburgh for the Diploma on Radiology in 1930, which he got with high distinction. After a short spell of radiological practice in London, he settled in South Africa, at first in Johannesburg and later in Cape Town, where he soon made his mark. As a diagnostic radiologist he held a high place amongst his contemporaries and his status was recognized by the University of Cape Town, which appointed him examiner for its diploma in Radiology.

He was a frequent contributer to the Medical Press and an active member of the Medical Association of South Africa. The Second Great War found him in charge of a Radiological Unit which he had completely organized *ab initio*, and the close of the war saw him Honorary Secretary of a large branch of the Ex-service Medical Officers Society, and this work held his attention until failing health in 1948 compelled him to relinquish practice. Here it was that his great qualities of zeal and determination, coupled with his loyalty to his fellow servicemen, bore most fruit. His dour efficiency and driving personality earned for him the gratitude of many old associates, but the effort he made was at the expense of his health. A crippled and failing heart made him chafe against compulsory rest, yet, when during the closing phases of his life he had to endure severe pain and physical discomfort, he faced the inevitable with courageous fortitude. Dr. Montgomery had wide interests outside his professional work. He had received the honor of Fellowship of the Linnaean Society for his monographs on "Crustacea Brachyura" and "Crabs of Western Australia" and had planned for his leisure hours a study of the diatoms of the False Bay Coast. He was fond of good music and a lover of poetry, deeply religious and very reserved and modest in his social contacts, yet withal a loyal friend and a fearless fighter against injustice in any form.

His passing at the early age of 54 leaves a gap in a wide circle of friends. Science has lost a keen worker, an idealist, and the type of man it could ill spare. He leaves a widow, a son and a daughter, to whom we tender our deep sympathy.

David P. Marais, M.D., Regent for South Africa.

A. J. COHEN

1879-1949

Abraham J. Cohen, M.D., of Philadelphia, Pennsylvania, died after a short illness on December 30, 1949. Dr. Cohen was born in Poland in 1879 and came to this country at the age of five. He graduated from Jefferson Medical College in 1903; interned at the Jewish Hospital, Philadelphia, from 1903 until 1905.

Early in his medical career he was influenced by Dr. Lawrence Flick and developed an intense interest in tuberculosis. This continued throughout his entire lifetime.

Dr. Cohen was a member of the Staff of the Henry Phipps Institute for the Study and Treatment of Tuberculosis from 1905 until 1911 and was Associate Director of the Clinical and Sociological Departments of that institution from 1920 to 1927. He was Visiting Physician to the White Haven Sanatorium from 1907 to 1911; Visiting Physician to the Chest Division of the Jewish Hospital from 1907 to 1920 and consultant in Chest Diseases at the same hospital from 1920 until 1949.

In 1909 Dr. Cohen founded the Eagleville Sanatorium for Consumptives which was the first tuberculosis sanatorium in this country located near a large city. He was the Medical Director and the leading spirit of that institution from the time of its founding until his death.

From 1919 until his death Dr. Cohen was clinical professor of Diseases of the Chest at Temple University Medical School. He was consulting physician to the tuberculosis division of the Pennsylvania State Hospital for Nervous Diseases in Norristown, Pennsylvania from 1930 until 1949; chairman of the Tuberculosis Committee, Philadelphia County Medical Society from 1940 to 1949; Chief, Tuberculosis Division, Philadelphia Department of Health from 1927 until 1931.

Dr. Cohen was a member of many local and national medical societies including the American Trudeau Society and the American College of Chest Physicians of which he was a charter member. He was a diplomat of the American Board of Internal Medicine and co-founder and twice President of the Laennec Society of Philadelphia.

For many years an advocate of the modern treatment of pulmonary tuberculosis Dr. Cohen was instrumental in popularizing artificial pneumothorax, pneumoperitoneum and the various major surgical procedures all of which were done at the Eagleville Sanatorium. Many physicians now active in the fight against tuberculosis received invaluable early training under his guidance.

Dr. Cohen contributed many papers to medical societies, the most recent of which was entitled "Forty Years' Experience with Artificial Pneumothorax" which was presented at the 15th Annual Meeting, American College of Chest Physicians in June 1949, and was published in its January 1950 issue of "Diseases of the Chest."

Dr. Cohen is survived by his wife Eugenia, his son Dr. Robert V. who was associated with him in his medical work, a brother Dr. Louis Cohen now Clinical Professor of Diseases of the Chest at Temple University Medical School and Medical Director of the Eagleville Sanatorium and two other brothers and three sisters.

Burgess Gordon, M.D., Governor for Pennsylvania.

CHESTER J. MELLIES
1904-1949

Dr. Mellies was born in Owensville, Missouri, on October 12, 1904 and died on August 12, 1949. He was the son of Dr. and Mrs. Edward Mellies. After graduation from Owensville High School he entered the Rolla School of Mines, graduating in 1929. He graduated from St. Louis University in 1933 and interned at St. John's Hospital, St. Louis, Missouri, for two years. In 1936 he was appointed surgeon of the Missouri State Sanatorium, Mt. Vernon, Missouri and held that position until entering the Army in August of 1941 from which he was discharged with the rank of Colonel. He served in the European theatre for forty-one months. His decorations while in the service were made by the French Army as follows: Legion of Honor, Croix de Guerre with palm and Croix de Guerre with bronze star. He began his private practice in Sikeston, Missouri in February of 1946 and continued until two weeks before his death. Dr. Mellies is survived by his wife, son and daughter, his parents, two brothers and two sisters.

Dr. Mellies was very fond of fishing and hunting. He also was an expert on photography. He is the author of several articles on various chest subjects and was prominent in his local medical society. He was a member of the American College of Chest Physicians, American College of Surgeons, Southern Medical Association and the American Heart Association.

It is with regret that the American College of Chest Physicians announces the loss of this valued member.

Alfred Goldman, M.D., Governor for Missouri.

Medical Service Bureau

POSITIONS AVAILABLE

Pennsylvania physician wanted, 750 bed tuberculosis hospital on main highway and P.R.R. Some knowledge of tuberculosis preferred but not necessary. Pennsylvania license or reciprocity required. Apartment for single man or man and wife. All phases of tuberculosis including major chest surgery. Retirement privileges. Inquire Medical Director, State Tuberculosis Sanatorium, Cresson, Pennsylvania.

Physician wanted, man or woman, for 150 bed tuberculosis sanatorium (new hospital being built) in the southeast. Experience not necessary but desirable. Must be graduate of American school. Salary $6,000. For further information please address Box 207A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Two staff physicians wanted for a 400 bed tuberculosis section of a 1,000 bed general hospital located at Martinsburg, West Virginia. Salary open depending on qualifications. Living quarters available on hospital grounds at reasonable rates. Training in tuberculosis is desirable but not essential. West Virginia license is not required. Applicant must be a graduate of a Grade A United States medical school and a United States citizen. Please send full particulars and photograph with first letter. Address all information to Box 208A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Residency vacancy, chest surgery. For information apply Secretary, Interne Committee, Vancouver Gen. Hospital, Vancouver, B. C., Canada.

Staff physicians and clinical director wanted for tuberculosis sanatorium in Texas. Chest surgeon also wanted for new chest surgery division. New, completely furnished homes available for medical staff. For further information please address Box 209A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Experienced physician wanted in tuberculosis work for private tuberculosis sanatorium, 130 beds. Salary $7,500 per year plus extra for outpatient work, plus full maintenance for single or married man; no children. Please give all information in first letter concerning age, experience and references. Write to Dr. Louis Mark, Rocky Glen Sanatorium, McConnelsville, Ohio.

Senior resident physician wanted for a modern 240 bed New Jersey tuberculosis sanatorium. An American graduate with adequate training in a modern tuberculosis sanatorium. Experience in selecting surgical tuberculous cases and with postoperative care is required. Licensing in the state of New Jersey required. Civil Service examination not required. We do not have a state income tax. Doctor with wife and on child acceptable. Complete maintenance on the grounds granted. Salary open. Please give complete information in first letter. Address Box 210A, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Ill.

Physicians wanted, salary $6,000 to $7,500 depending upon qualifications, training, etc. No maintenance, 5-day week. Private practice permitted. Large metropolitan midwest sanatorium. Please address Box 211A, American College of Chest Physicians, 500 N. Dearborn St., Chicago 10, Ill.

Tuberculosis staff physician wanted, 104-bed new state tuberculosis hospital in city of 45,000 in southwest Louisiana. Experience in tuberculosis not necessary. Must have Louisiana license or be eligible for reciprocity. Hospital has all medical and surgical facilities for treatment of tuberculosis. Maintenance for single man can be furnished but housing is available outside and nearby for family man. Opening at present for temporary or permanent applicant, salary $400 per month. Apply immediately to Dr. J. O. Duhon, Lafayette Charity Hospital, Lafayette, La.

POSITIONS WANTED

Chest specialist, 38 years old, desires change in position. Ten years experience in leading institutions. Clinical and administrative background. Institutional, tuberculosis control, or private practice association considered. Please address Box 243B, American College of Chest Physicians, 500 North Dearborn Street, Chicago 10, Illinois.

Directorship or Assistant Directorship in a tuberculosis hospital wanted. Outstanding chest specialist with excellent qualifications, experience and ability. Well experienced in all phases of tuberculosis. Best references. Now holding responsible position. Graduate Class A American school. Salary should be adequate to warrant this change. Please write Box 244B, American College of Chest Physicians, 500 N. Dearborn St., Chicago 10, Ill.

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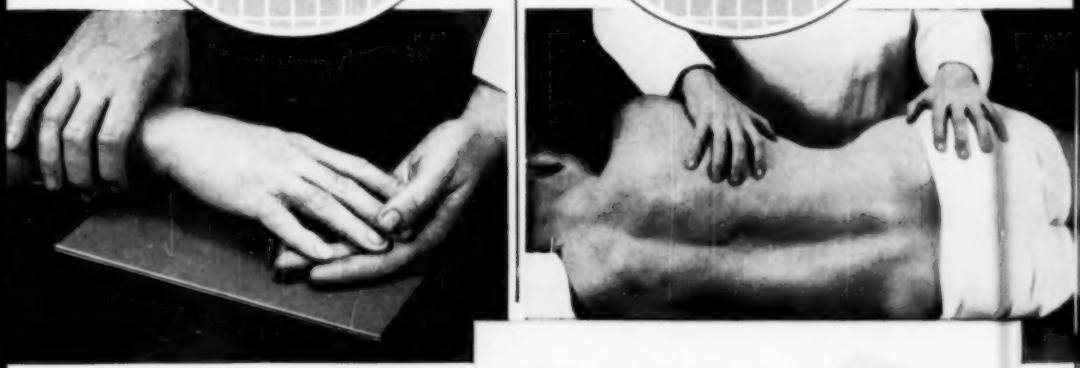

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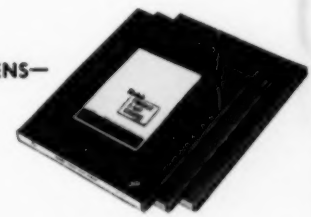

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REF.: Hinshaw, H. C. and McDermott, W. Report to the Clinical Subcommittee of the Committee on Medical Research and Therapy, Amer. Review of Tuberculosis, 1950, 61, 157

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